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EVALUATION OF EXISTING STRUCTURES

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EVALUATION OF EXISTING STRUCTURES

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The objective of the overall research program is to develop an evaluation procedure applicable to existing NSS-type structures and private homes. Past efforts have been concerned with examining exterior walls; window glass; steel frame connections; applications to actual buildings; reinforced concrete floor systems, including restrained slabs; wood-joist floors; and the dynamic inelastic analysis of a steel . .. building. Since this is the final report in this effort, a summary of the evaluation procedure for existing structures is presented in the

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report. Also included is the flow chart developed for a computer program to analyze a building subsystem; i.e., the dynamic response and collapse of all exterior and interior walls on one floor level of a building. An analysis made to determine the blast resistance of basement walls of Emergency Operating Centers is presented. Finally, the report contains a complete listing of all computer programs developed during the project for analyzing the dynamic response and collapse of wall and floor elements.

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SUMMARY

Introduction

The objective of this investigation was to develop an evaluation procedure for determining the blast protection afforded by existing NSS-type structures and private residences. The procedure developed consists basically of (1) a method for determining the air blast loading on the structure and structural elements, (2) a method for determining the dynamic structural response up to collapse, and (3) a method for establishing the failure criterion for each structural member of interest. The analytical method used was to establish the resistance function for each wall or floor element by considering the approximate response mode and by assuming that the element was subjected to a uniformly distributed static load. The member was then transformed into an equivalent single-degree-of-freedom dynamic system, and the equation of motion solved on a computer using a numerical integration procedure.

Background

The primary interest from the inception of this study has been the development of an evaluation procedure for analyzing the dynamic response and collapse of the building system. However, the complexity of a comprehensive evaluation procedure for a building system necessitated that important building elements be treated first. Therefore, the initial effort in the program was directed primarily toward the development of mathematical models to analyze the dynamic response and collapse of various types of one-way action walls. Also, the behavior of window glass and steel-frame connections were examined as part of the initial study.

The analytical procedures were then extended to include two-way walls, and a probability approach was incorporated into the evaluation procedure. Next, mathematical models were developed to analyze dynamically loaded reinforced concrete floor systems of various types, and wood-joist floors. During the conduct of the research program, the evaluation procedure has been used to predict the collapse overpressure of a large number of exterior walls and floors over basement areas for existing NSS buildings. As part of this effort, the relative collapse strength of the exterior walls and frame of a multistory steel-frame building was examined.

A summary of the evaluation procedure for existing structures is contained in this final report. Also included is a flow chart for a computer program to analyze a building subsystem, and an analysis of the blast resistance of basement walls located in areaways of Emergency Operating Centers (EOCs). An appendix of the report contains a complete listing of all computer programs developed during the study to analyze dynamically loaded wall and floor elements.

Discussion

The computer programs for the evaluation of existing structures were developed as individual programs to analyze various types of wall and floor elements. Although this approach permitted the analysis of actual structures to be made sooner than would otherwise be possible, as well as being convenient for correlation of analytical models with experimental data, there was a need to develop a computer program to analyze the building system. As the next logical step in the development of an overall building program, a flow chart was developed for a building subsystem. The subsystem selected was all exterior and interior walls on one floor of a building. The report presents the flow chart for a computer program to analyze each wall on a room-by-room basis as the blast wave moves through the building.

The collapse strength of reinforced concrete basement walls was examined to determine the feasibility of retrofitting EOCs with doors to resist the 10-psi blast overpressure level. Although mathematical models have been developed for walls with window openings, the evaluation procedures were not extended to include walls with door openings. Since there was insufficient time to develop a generalized model for calculating the resistance and response of the wall configuration of interest, the following three-phase approach was used:

(1) A detailed yield-line analysis of several specific reinforced concrete walls with door openings was made to establish the static resistance over a limited range of wall widths.

(2) The computer program for analyzing the collapse of wall elements, developed by SRI for DCPA, was used to calculate the resistance of walls without door openings. The results were then compared with those obtained from the yield-line analysis for walls with door openings to determine the feasibility of using the existing computer program to simulate the dynamic response of walls with door openings. If the resistances for the two wall types was found to be not comparable, then it would be necessary to hand calculate a resistance function for each wall case.

(3) An existing finite element computer program was used to analyze the static behavior for a few cases of walls with door openings to determine if shear or stress concentrations could conceivably produce a wall failure not predictable by the other analyses.

The various analyses led to a few general conclusions concerning the collapse of blast loaded reinforced concrete basement walls with door openings and located in areaways. First, for reinforced concrete walls 8-in. thick or thicker, and not over 10-ft high, it is probable that the wall strength of the weakest code-designed wall is sufficient to resist

a 10-psi blast loading if the horizontal distance from the edge of the door opening to the areaway support wall is less than approximately 20 in. (L_H = 84 in.).

Second, for 8-in.-thick walls with horizontal distance between door opening and areaway wall greater than 20 in., it will be necessary to strengthen the wall in the vicinity of the door opening so as to upgrade the wall to the 10-psi blast overpressure level.

Third, for reinforced concrete basement walls 12-in thick or thicker, the blast strength can be expected to be approximately equal to or greater than the 10-psi blast overpressure criterion for all wall conditions.

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EVALUATION OF EXISTING STRUCTURES

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Prepared for:

CIVIL DEFENSE PREPAREDNESS AGENCY
WASHINGTON, D.C. 20301

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ABSTRACT

The objective of the overall research program is to develop an evaluation procedure applicable to existing NSS-type structures and private homes. Past efforts have been concerned with examining exterior walls; window glass; steel frame connections; applications to actual buildings; reinforced concrete floor systems, including restrained slabs, wood-joist floors; and the dynamic inelastic analysis of a steel frame building. Since this is the final report in this effort, a summary of the evaluation procedure for existing structures is presented in the report. Also included is the flow chart developed for a computer program to analyze a building subsystem; i.e., the dynamic response and collapse of all exterior and interior walls on one floor level of a building. An analysis made to determine the blast resistance of basement walls of Emergency Operating Centers is presented. Finally, the report contains a complete listing of all computer programs developed during the project for analyzing the dynamic response and collapse of wall and floor elements.

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I INTRODUCTION

Under contract to the Defense Civil Preparedness Agency, Stanford Research Institute is developing a procedure for the evaluation of existing structures subjected to nuclear air blast. The objective of the program is to develop an evaluation procedure applicable to existing NSS-type structures and private homes. This report covers the final phase of the program.

Background

The Defense Civil Preparedness Agency has a number of problem areas in which an evaluation procedure for existing structures can be applied. These include:

- Survival and injury predictions
- Debris prediction
- Damage assessment
- Selection of existing structures that provide the best protection
- Selection of existing structures that have a potential for modification to provide blast shelters.

Even with the availability of high-speed computers, it was apparent that the complexity of an overall building evaluation procedure to meet the needs of DCPA could lead to considerable unwarranted computational effort if care was not exercised in the selection of the methodology. Therefore, relatively simplified air blast loading and room-filling procedures, as well as simplified structural response analytical methods, have been used in the evaluation program.

Although the primary interest from the inception of the program has been in the behavior and collapse of the building system, the complexity

of a comprehensive evaluation procedure necessitated the establishment of a priority for determining which structural element to investigate first. It is apparent that the collapse of the exterior walls of most buildings is important to the casualties produced. This is especially true for large multistory buildings where the collapse of the exterior and interior walls could result in a large number of casualties through ejection from the building, even if the floors and frame remained intact. Since one of the primary uses of a building evaluation procedure is to provide input for prediction of survival of people located in buildings subjected to nuclear blast, the initial research effort was directed towards the development of a method to determine the response and collapse of exterior wall elements.

Subsequent to the development of the wall evaluation procedure, the procedures for analyzing the collapse of floor systems were developed. Although there were insufficient funds in the program to develop a procedure for evaluating the collapse of structural frames, it was possible to use an available elastic and inelastic computer program to analyze the dynamic response of a steel frame building and estimate the frame collapse overpressure. During the final phase of the research, a computer flow diagram was developed for analyzing a building subsystem; i.e., for predicting the time sequence of collapse of all exterior and interior walls on one floor of a building on a room-by-room basis. However, the computer program could not be written within the level of effort of the contract.

Past reports in this program have been concerned with examining exterior walls (Ref. 1),* window glass (Ref. 2), steel-frame connections (Ref. 3), two-way action walls (Ref. 4), applications to NSS buildings

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* References are listed after the appendix.

(Refs. 5 and 6), reinforced concrete floor systems (Refs. 7 and 8), and wood-joist floors, and frame analysis (Ref. 8).

Report Organization

Since this is the final report on the research effort, a summary of the evaluation procedure is presented in Section II. A flow chart for the analysis of all walls on one floor level of a building (a building subsystem) is presented in Section III "Building System Program." The analysis of basement walls located in areaways is given in Section IV. During the project for evaluation of existing structures, computer programs were developed for analyzing the dynamic collapse strength of three types of wall elements and five types of floor system elements. The listings for the eight programs are included in the Appendix.

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II EVALUATION OF EXISTING STRUCTURES

Approach

The overall approach adopted in this study for the evaluation of existing structures subjected to nuclear air blast has been to formulate a procedure for examining the response of a structure over a range of incident overpressure levels to determine the overpressure at which collapse will occur. Basically, the procedure consists of (1) a method for determining the air blast loading on the structure and structural elements, (2) a method for determining the dynamic structural response up to collapse, and (3) a method for establishing the failure criterion for each structural member of interest. An iterative process is employed in which the structural response can be examined for various levels of incident overpressure and compared with a failure criterion to predict the overpressure level at which collapse of each member will occur.

Wall and Floor Evaluation Procedure

Introduction

The analytical method used in the research study was to establish the resistance function for each wall or floor element of interest by considering the approximate response mode and by assuming that the element was subjected to a uniformly distributed static load. The member was then transformed into an equivalent single-degree-of-freedom dynamic system by the use of the transformation factors for the load, resistance, and mass. The equation of motion was then solved on a computer using the numerical integration procedure described in Ref. 9. Although the approach has been

to use established analytical procedures wherever possible, it has been necessary to modify and adapt current procedures, as well as develop new methods, for specific uses.

The method followed in developing the wall and floor evaluation procedure was to (1) develop a mathematical model for each element of interest, (2) prepare the computer program, and (3) verify the analytical predictions with the available published test information on the dynamic response and collapse of wall and floor elements.

Although the mathematical models were formulated by using established analytical procedures, as noted in the referenced reports on the evaluation procedure for existing structures, the available published test data were adequate for correlation with only some of the analytical models. However, for other cases* there was a lack of definitive experimental information that adequately described the load-response relationship up to collapse. Although all mathematical models could not be correlated sufficiently with appropriate experimental data, the use of probability functions i. the procedures for predicting the incipient collapse overpressure o tne elements makes the use of precise resistance functions less critical than would otherwise be the case.

For the evaluation of existing structures, failure implies collapse or disintegration of the structural element. Furthermore, the predicted collapse overpressures calculated are for the incipient collapse of the element, which is defined as that point in the response where the wall or floor can be considered as on the threshold of collapse. The incipient collapse overpressure is just sufficient in magnitude to cause a collapse of the element.

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* For example, the inelastic response up to collapse of a two-way lightly reinforced concrete wall with a window opening and with vertical in-plane forces acting on the wall.

Wall Analysis

The three basic types of exterior walls considered in the evaluation procedure are unreinforced concrete or masonry unit walls without arching, unreinforced concrete or masonry unit walls with arching, and reinforced concrete walls. The details of the development of the wall evaluation procedures are presented in Ref. 1 for one-way action walls and Ref. 4 for two-way walls.

For unreinforced masonry unit walls without arching and for reinforced concrete walls, resistance functions were developed for the following type of wall support conditions:

- Two-way, simply supported on four edges
- Two-way, fixed on four edges
- Two-way, fixed on vertical edges; simply supported on horizontal edges
- Two-way, simply supported on vertical edges; fixed on horizontal edges
- One-way, simply supported on opposite edges
- One-way, fixed on opposite edges
- One-way propped cantilever
- One-way, cantilever.

For unreinforced walls with arching, resistance functions were developed for one- and two-way action walls with rigid supports.

Floor System Analysis

One of the interests of DCPA has been the possible use of basements of existing NSS structures as blast shelter areas, and therefore the research effort was primarily concerned with developing methods for predicting the collapse of various types of reinforced concrete floor systems.

However, the resistance function for wood-joist floors was also developed. The details of the floor system evaluation procedures are presented in Refs. 7 and 8.

The types of floor elements included in the evaluation procedure are as follows:

- One- and two-way reinforced concrete solid slabs
- Two-way restrained reinforced concrete solid slab
- Reinforced concrete support beam (including T-beam and joist)
- Structural steel support beam (including composite action)
- Reinforced concrete flat slab
- Reinforced concrete flat plate
- Wood-joist floor

Probability Considerations

The analysis of actual building elements subjected to nuclear air blast requires the assumption of values for many of the physical properties of the structure that are unknown and cannot be measured without an unwarranted amount of effort. Similarly, assumptions are also required in the determination of the parameters defining the load acting on the building element. Since precise values cannot usually be specified for many of the parameters that influence the collapse of actual structures, a probabilistic approach was formulated to provide a realistic evaluation of existing structures subjected to nuclear air blast (Ref. 4).

It is apparent that the determination of the incipient collapse overpressure for a given wall or floor depends on a number of variables, at least some of which must be considered to be randomly distributed. Although the probability distribution of these random variables may be determined fairly easily, at least as approximations, the extension of this step to determine the probability distribution of the resulting

collapse overpressure is not so easy. Since it was not possible to obtain an exact distribution, it was decided to use Monte Carlo, or simulation, techniques to determine the probability distribution for the incipient collapse overpressure.

This technique uses a set of mathematically simulated wall or floor elements, each of which possesses the characteristics of some real wall or floor to determine an approximate distribution of the incipient collapse overpressure. This set of simulated walls or floors is prepared by selecting the parameters to be varied and determining the values of these parameters by randomly sampling their corresponding probability distribution functions. Each simulated wall or floor is then analyzed by using the deterministic equations developed previously. The results of these analyses provide a probability distribution of the incipient collapse overpressure. It should be noted that the collapse overpressure of a wall or floor element can also be calculated deterministically.

Air Blast Loading

An important factor in the evaluation of existing structures subjected to nuclear air blast is the determination of the pressure-time function on each structural element of interest. This is a complex problem, since, even before the blast wave interacts with the structure, the blast wave is influenced by many factors, such as weapon yield and location, weather conditions, terrain, surface type, and blast shielding. Even if it were assumed that the free-field, pressure-time relationship were known for a blast wave incident on the side of a building, the determination of the loading function on a wall or floor element is difficult because of the interaction processes. The primary difficulty arises because the structural element responds to the differential or net loading, which requires a knowledge of the loading on both the front and back surfaces.

For the evaluation of existing structures subjected to nuclear air blast, it was assumed that the blast wave before interacting with the structure was an ideal Mach waveform propagating radially outward over an ideal reflecting surface. It was also assumed that the duration of positive phase of the dynamic overpressure was equal to that of the side-on overpressure and that the negative phase could be neglected for structural response calculations. The method used to determine the pressure-time function of an exterior wall is presented in detail in Ref. 4, and involves the calculation of an exterior, interior, and net loading.

To calculate the average load-time history on the exterior wall, the conventional air blast loading scheme for a closed rectangular block is used (Ref. 10). For the front face of a building with window openings, the conventional scheme is modified by using the weighted average clearing distance presented in Ref. 11. To calculate the interior pressure build up resulting from the air blast entering the building through openings, the room-filling procedure presented in Ref. 12 is used. For each specific problem, the net wall loading is obtained by a simple summation of the exterior and interior pressure-time histories.

In addition to the ideal air blast loading, the evaluation procedure for exterior walls includes the following loading schemes:

- Triangular load
- Rectangular load
- URS shock tunnel load
- Arbitrary load.

For the dynamic analysis of floor systems subjected to nuclear air blast, two load-time functions were included in the evaluation procedure. The first load type was equal to the free-field blast overpressure, except with a rise time equal to the travel time of the wave front across the floor panel. The second load type was equal to the room-filling pressure

resulting from the interaction of an ideal air blast wave with a structure with window openings. In addition, the floor evaluation procedure includes an arbitrary load shape.

It should be noted that although the net load-time function resulting from a nuclear air blast is calculated so as to analyze the dynamic response of a wall or floor element, a description of the net load-time function is not too meaningful for comparing collapse predictions for elements of various structures. Therefore, the predicted collapse overpressures given in this study are the peak incident overpressures of the free-field blast wave that results in collapse of the element.

Applications

As part of an integrated program to develop a survey procedure for all nuclear weapon effects, Research Triangle Institute (RTI) made an initial on-site field survey during November 1970 of five NSS buildings in Detroit, Michigan. The survey was conducted primarily to obtain a complete structural description of buildings that would be adequate for predicting building damage and casualties. The results of the field survey were recorded on forms and included sketches and photographs. A complete copy of this information, together with the building plans, was provided to SRI for analysis of the buildings. The results of the dynamic analysis of the exterior walls of the five Detroit buildings are presented in Ref. 5.

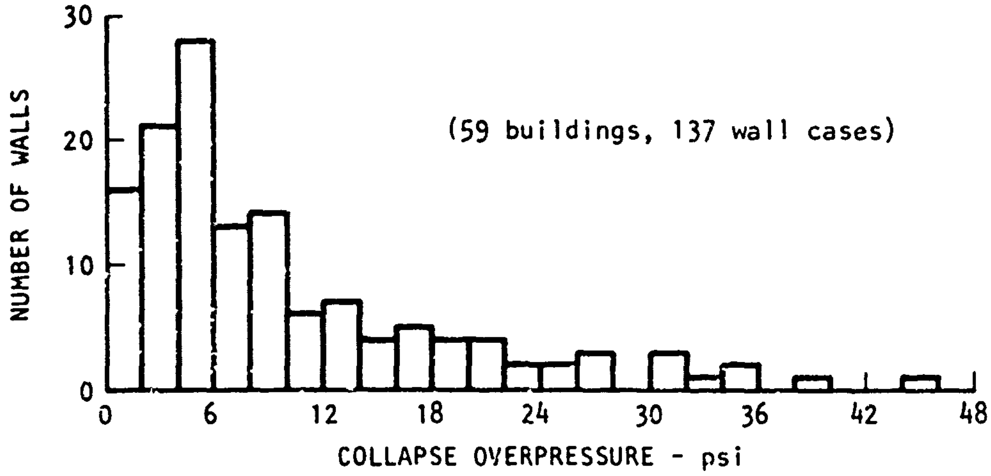
To provide additional input information for the development of the all-effects survey, RTI made a second on-site field survey in July 1971 of five buildings in the vicinity of Greensboro, North Carolina. As in the analysis of the Detroit buildings presented in Ref. 5, two dynamic analyses were made of each of the Greensboro buildings. The first analysis was made using the data obtained during the RTI on-site survey.

A second analysis of the same building was then made independently using data obtained from the actual building plans. This procedure provided a check on the adequacy of the survey technique and the proposed field survey data form, and emphasized areas of possible improvement. The results of the dynamic analysis of the exterior walls of the five Greensboro-High Point buildings are presented in Ref. 6.

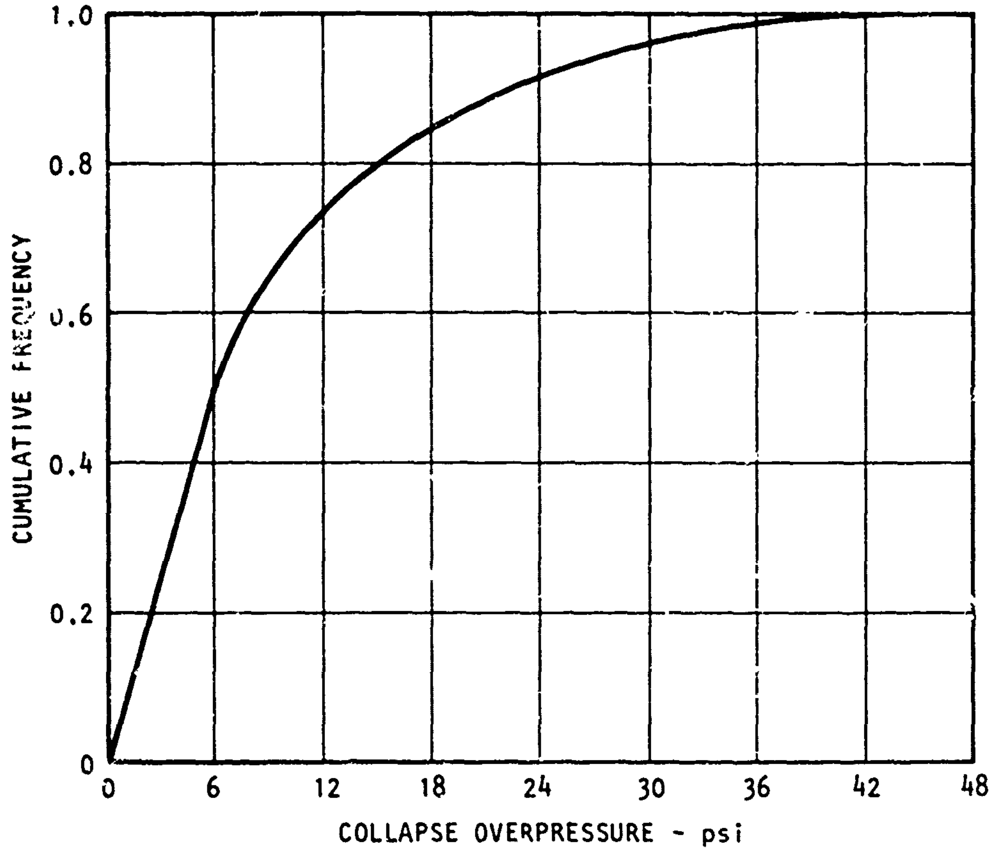
In addition to the two research studies to develop an all-effects shelter survey procedure, RTI also collected data on a national sample of NSS buildings for the Engineering Directorate of DCPA (Ref. 13). Of the 219 NSS buildings comprising the national sample, the SRI evaluation procedure was used to predict the collapse overpressure of the exterior walls for 50 of the buildings and of floors over basement areas for 36 of the buildings. Since the results of the dynamic analyses of the walls and floors of actual buildings are of interest to the evaluation of existing structures program, a short summary of the findings are presented in this report.

Walls

The collapse predictions for the exterior walls of NSS buildings required the dynamic analysis of 137 wall cases. These walls represent 59 NSS buildings, which can be categorized as 15 load-bearing wall buildings, 23 structural steel frame buildings, and 21 reinforced concrete frame buildings. Figure 1 shows a histogram and cumulative frequency distribution of the mean collapse overpressure for the 137-wall population. The data indicate that for the 59 sample buildings, 50 percent of the exterior walls are predicted to have a mean collapse overpressure of 6 psi or less, and 90 percent are predicted to have a mean collapse overpressure of 22 psi or less.



(a) Histogram for all wall cases



(b) Cumulative frequency distribution for all wall cases

FIGURE 1 HISTOGRAM AND CUMULATIVE FREQUENCY DISTRIBUTION OF THE MEAN COLLAPSE OVERPRESSURE FOR THE EXTERIOR WALLS OF 59 BUILDINGS

The effect of the type of frame on the collapse strength of exterior walls is indicated by the cumulative frequency distributions for the wall collapse overpressures shown in Figure 2 for the three major building frame categories. Although the data are considered as insufficient to establish quantitatively the effect of frame type on wall collapse overpressure level, the trends in the data are apparent. The mean values of the collapse overpressures for walls are about 4.5 psi for load-bearing wall buildings, 6 psi for reinforced concrete frame buildings, and 10 psi for steel frame buildings.

Floors

The collapse predictions for the floor systems over basement areas of NSS buildings required the dynamic analysis of 82 floor cases, which represent 36 buildings. Figure 3 shows a histogram and cumulative frequency distribution of the collapse overpressures for all floors. As noted on the figure, the collapse overpressure for floors over basement areas ranged from about 2 to 55 psi, with 50 percent of the floors predicted to collapse at 7 psi or less and 90 percent predicted to collapse at 18 psi or less.

Frame Analysis

A continuing concern in evaluating the collapse overpressure of existing buildings has been the relative blast strength of the exterior walls and frames of multistory buildings. To predict the collapse overpressure of the exterior walls for the existing NSS buildings discussed in the previous subsection, it was assumed that the structural frame did not collapse at a lower overpressure than that predicted for the exterior walls. For weak-walled buildings, such an assumption is reasonable. In fact, it is often assumed for the analysis of blast loaded frame buildings that the exterior walls can be considered as frangible,

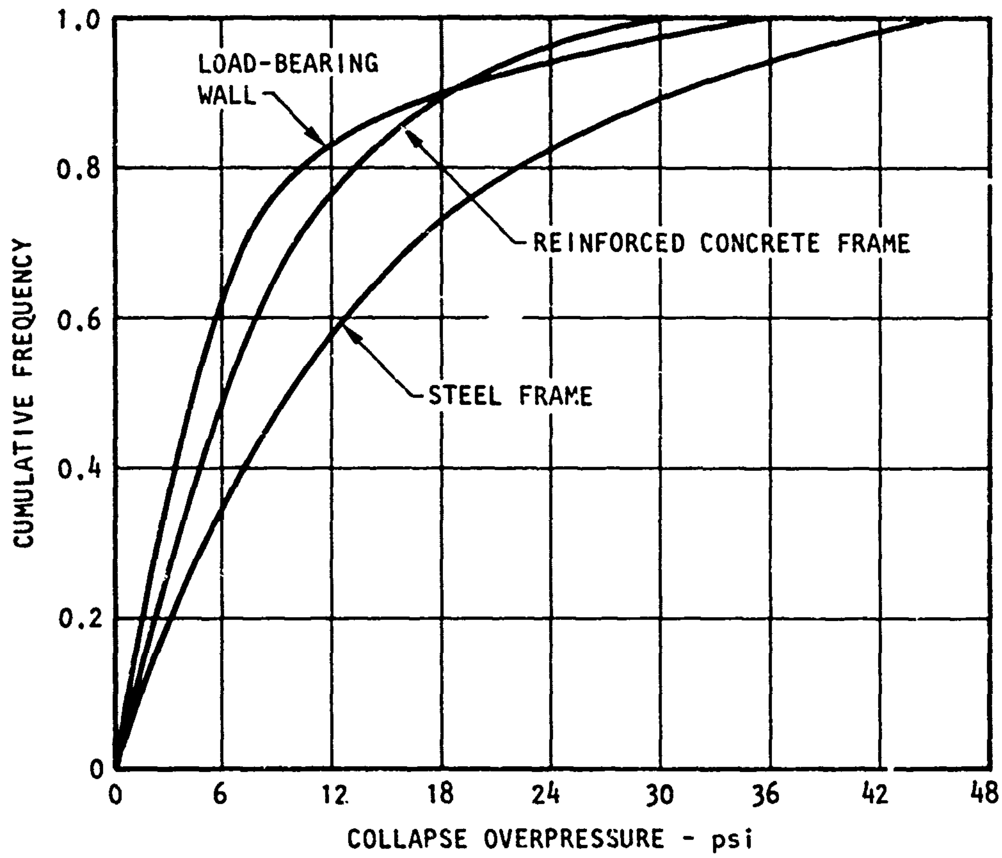
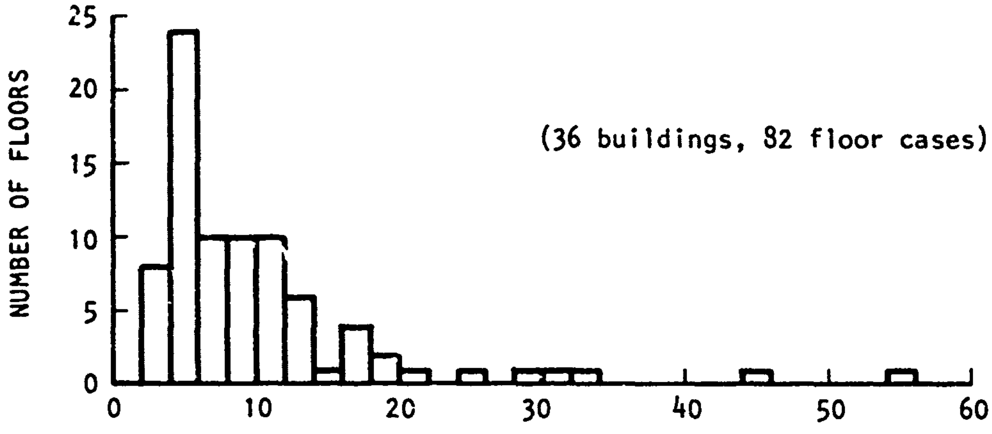
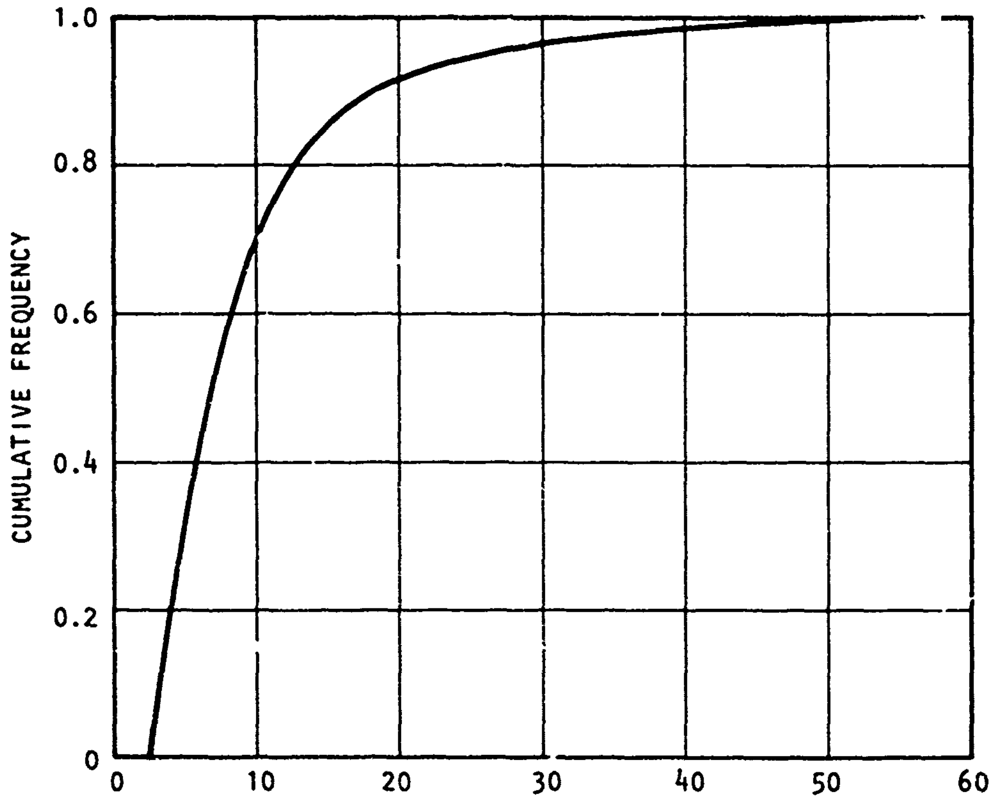


FIGURE 2 COMPARISON OF THE CUMULATIVE FREQUENCY DISTRIBUTIONS OF THE MEAN COLLAPSE OVERPRESSURE FOR EXTERIOR WALLS BY THE TYPE OF BUILDING FRAME



(a) Histogram for all floor cases



(b) Cumulative frequency distribution for all floor cases

FIGURE 3 HISTOGRAM AND CUMULATIVE FREQUENCY DISTRIBUTION OF THE MEAN COLLAPSE OVERPRESSURE FOR THE FLOORS OVER BASEMENT AREAS OF 36 BUILDINGS

and therefore, that the wall loading transferred to the frame can be approximated by an impulse loading. However, for many of the actual buildings analyzed, the strength of the exterior walls under blast loading was sufficiently high to make it doubtful that the frame could survive at the overpressure level required to collapse the walls. For example, Figure 1 shows that 50 percent of the walls of the NSS buildings analyzed were predicted to collapse at an overpressure level greater than 6 psi. The strength of the exterior walls is important in calculating the collapse of the frame, since, for a given overpressure level, the blast loading on the total wall area can be much more severe than the blast loading on the frame alone plus an impulse loading from a frangible-type wall.

To investigate the relative strength of the exterior walls and frame of a building would require a comprehensive computer program that includes inelastic response under dynamic loading as well as realistic frame collapse mechanisms. Since such a program was not available, a computer program for analyzing the elastic and inelastic dynamic response of two-dimensional structural frames was used (Ref. 14). Although the program does not include frame collapse mechanisms, it was felt that the results would provide a basis for estimating the possible collapse strength of a building frame relative to the strength of the exterior walls.

The building selected for analysis was the North Carolina National Bank, Greensboro, North Carolina. The building has a structural steel frame, and consists of eight stories, with a height of about 110 ft, and plan dimensions of 50 ft by 115 ft. A complete description of the bank building and the results of the analysis of the exterior walls are given in Ref. 6. The exterior walls on the upper stories consist of a 4-in.-thick brick veneer, which is continuous over the frame members, and an 8-in.-thick terra cotta backing wythe, which is inset in the frame and parged to the brick veneer.

Three different types of frame analyses were performed: (1) an elastic analysis to determine the strength of the inset walls on the ends of the building acting as shear walls, (2) elastic frame analyses at various overpressure levels, and (3) inelastic frame analyses at various overpressure levels. The exterior walls of the building were previously found to have an incipient collapse overpressure (50 percent probability) of 15.7 psi (Ref. 6), and therefore the blast loading for the frame analyses are calculated for a box-type building with nonfailing exterior walls with window openings.

The results of the analyses provide an estimate of the collapse strength of the structural steel frame of the bank building under blast loading, even though the computer program used cannot predict frame collapse. The results of the first analysis, for the shear wall building, indicated that the cracking of the exterior walls acting as shear walls occurs at an incident overpressure level of less than 2 psi, since the moment ratios (computed moment/yield moment) for the shear walls are above 35 for a 2-psi incident overpressure level. Therefore, it was assumed for the other two types of analyses that the inset end walls acting as shear walls contributed negligible resistance to the frame, and that the analysis of the frame acting alone should adequately model the building behavior under lateral load.

An elastic analysis of the frames for 16 psi, which approximated the incipient collapse overpressure of the exterior walls, indicated a maximum stress ratio (computed stress/stress at yield) of about 20. Since the elastic analysis is much simpler than the inelastic analysis, the frames were then analyzed for elastic behavior at 5-, 4-, and 3-psi overpressures to obtain an estimate of the frame strength. The results of the elastic analyses indicated that the strength of the frames was in the range of the lower overpressures examined, and therefore the inelastic frame analyses were run at 3-, 4-, and 5-psi overpressure levels.

The inelastic analyses indicated maximum ductility ratios at 3 psi of 13.4 for the beams and 20.6 for the columns, and maximum moment ratios of about 1.64 for the beams and columns. At the 4-psi overpressure level, the maximum ductility ratios were 29.5 in the beams and 42.2 in the columns, and the maximum moment ratios were in excess of 2. A simplified hand calculation indicated that the P-Δ effect, which is not included in the computer program, would increase some of the moment ratios by over 50 percent. The calculated lateral deflection of the top story of the building was about 21 ft for the 3-psi overpressure level, and 47 ft for the 4-psi level. If it is assumed that the frame would collapse at a ductility ratio of about 50, then the estimated collapse overpressure is between 3-, and 4-psi incident overpressure level. The actual blast strength could be much less, since the effect of the axial column load (P-Δ effect) and frame collapse mechanisms, such as column buckling or instability, are not accounted for in the analytical procedure.

It should be noted that the frame of the North Carolina National Bank building appears to be constructed of relatively light structural shapes that may not necessarily be typical of most NSS structures. In any event, however, the analysis indicated that the blast resistance of the frame of the building was much less than (possibly only one-fourth) that of the exterior walls. This, of course, is an important consideration in predicting either building damage or casualties.

Building System Computer Program

Since the inception of the evaluation project, the intention has been to develop a procedure for the analysis of a building system that would be applicable to various requirements of DCPA. For predicting damage to NSS structures in this program, it was assumed that each wall analyzed could be treated as though it were the "front face" of the building with an ideal blast wave advancing at normal incidence to it.

The time-sequence of collapse of various building elements, or the effect of the engulfment of the building by the blast wave, is not directly accounted for in the current computer programs. For example, to use the computer codes for predicting the collapse of all exterior walls of a building (i.e., front, side, and back) for the blast approaching from one direction it is necessary to use engineering judgment in providing realistic input data. Such a procedure was used to correlate analytical predictions with nuclear field tests of brick load-bearing-wall houses (Ref. 4).

In order to systematize the building evaluation procedure, a flow diagram was prepared during the current effort that outlines the computer analysis of all wall elements on one story of a building. The results are presented in Section III.

III BUILDING SYSTEM PROGRAM

The purpose of this phase of the research was to examine a method for systematizing the collapse predictions for blast loaded buildings. Since the inception of the existing structures evaluation project, the intention has been to develop a procedure for the analysis of a building system that would be applicable to various requirements of DCPA, such as damage assessment, survival and injury predictions, and debris predictions. Because of the complex nature of analyzing the response and collapse of buildings under dynamic loading, as well as the difficulty of calculating precise blast loadings on each element in a complex building geometry, the approach has been to establish a sound technical basis for the analysis of each building element. It has been necessary to derive realistic mathematical response models before computer codes could be prepared for the various structural elements of interest. Although the original intent was to develop subroutines for each element for the eventual incorporation into a single computer program, the need to analyze existing buildings preceded the completion of a building system program. Instead, relatively complete computer programs, as opposed to building element subroutines, were prepared for each building element; i.e., for each element the computer code consists of a main routine, a subroutine to calculate the resistance function, a subroutine to calculate transformation factors, subroutines to calculate the exterior and interior blast pressures and net load on the element, and a subroutine for calculating the probability of collapse. The development of these individual element programs diverted some effort from the development of a building system program; however, the individual programs permitted analyses of existing

buildings to be performed much sooner than would otherwise have been possible. Also, the availability of individual element programs was convenient for the correlation of experimental data with analytical models.

Essentially, the building element computer programs were developed as research tools for use in developing realistic analytical prediction models, and for performing limited analyses of buildings rather than for performing a large number of analyses of existing buildings. However, as originally intended, it has become apparent that a computer program for analyzing a building system, or at least a building subsystem, would be useful. Therefore, during this phase of the research effort, the feasibility of incorporating the previously developed computer programs for wall analysis into a program for the analysis of a subsystem of the overall building system was examined. Specifically, a relatively detailed flow diagram was prepared that outlines the procedure for analyzing all exterior and interior walls on one story of a building. During this phase, the computer flow chart was prepared, but the computer program was not written.

A subsystem analysis approach was chosen as the most expedient and logical next step in the development of an overall building evaluation procedure. Figure 4 shows a macroscopic organizational flow chart of the proposed program to be used. The subsystem is one floor level of a building that can be oriented at any angle to the blast wave front. For a given free-field overpressure level, the net loading on each wall element will be computed and the wall response calculated on a room-by-room basis as the blast wave moves through the building.

At the present time the evaluation procedure has the capability of calculating the exterior pressure-time environment resulting from an interacting blast wave, and can compute the resulting interior pressure

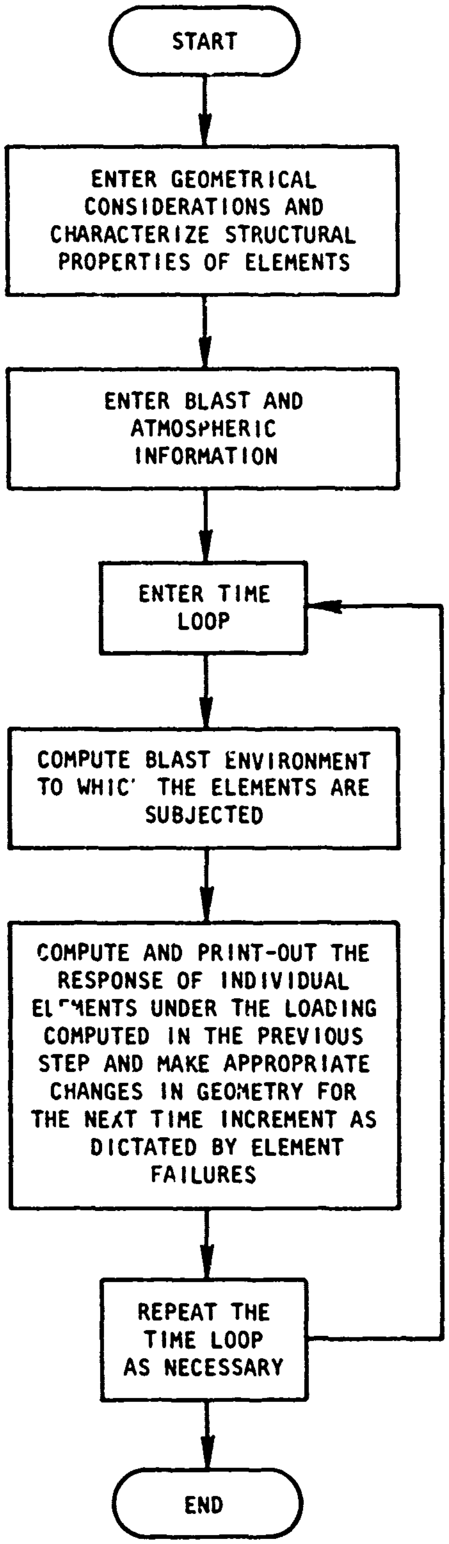


FIGURE 4 BUILDING SUBSYSTEM PROGRAM MACROSCOPIC ORGANIZATIONAL FLOW CHART

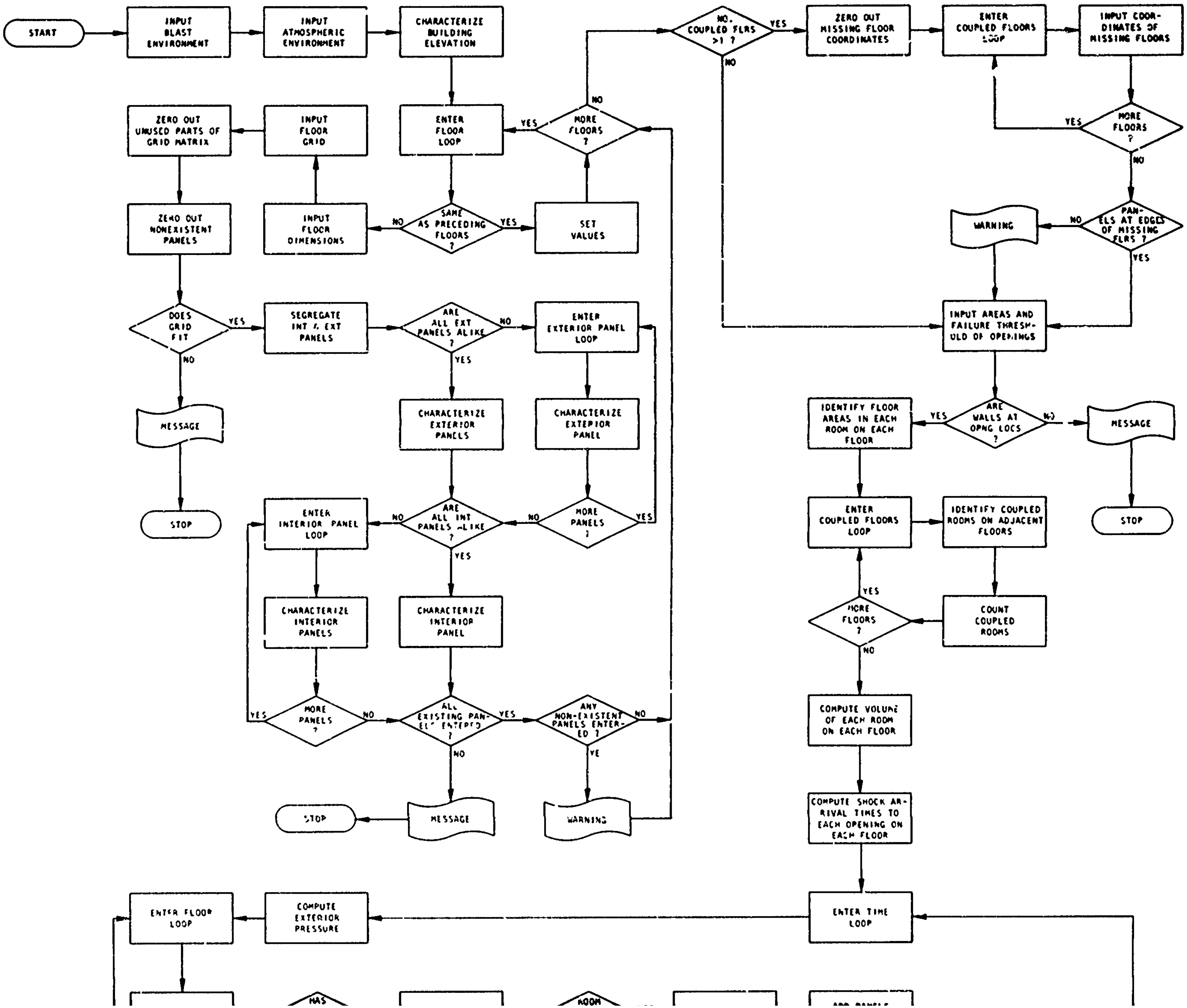
build-up to a single room. For the subsystem program, it will be necessary only to extend the capability to calculate the interior pressure in a multiroom complex by the method presented in Ref. 12. Also, as discussed previously, the mathematical models for predicting the response and collapse of walls are available. The remaining task consists of combining the loading and response models into a single subsystem program that includes the geometry of the floor of a building.

Figure 5 shows a detailed organizational flow chart of the proposed subsystem program. Table 1 is a list of abbreviations used in the flow chart.

Table I

ABBREVIATIONS USED
IN FLOW CHART

Abbreviation	Word Represented
EXT	EXTERIOR
INT	INTERIOR
OPNG	OPENING
FLR	FLOOR
PR	PAIR
ARVD	ARRIVED
RM	ROOM
NRST	NEAREST


START
INPUT BLAST ENVIRONMENT
INPUT ATMOSPHERIC ENVIRONMENT
CHARACTERIZE BUILDING ELEVATION
ENTER FLOOR LOOP
SAME AS PRECEDING FLOORS ?
YES
NO
SET VALUES
MORE FLOORS ?
INPUT FLOOR DIMENSIONS
INPUT FLOOR GRID
ZERO OUT UNUSED PARTS OF GRID MATRIX
ZERO OUT NONEXISTENT PANELS
DOES GRID FIT
MESSAGE
STOP
SEGREGATE INT & EXT PANELS
ARE ALL EXT PANELS ALIKE ?
ENTER EXTERIOR PANEL LOOP
CHARACTERIZE EXTERIOR PANEL
MORE PANELS ?
CHARACTERIZE EXTERIOR PANELS
ARE ALL INT PANELS ALIKE ?
ENTER INTERIOR PANEL LOOP
CHARACTERIZE INTERIOR PANELS
CHARACTERIZE INTERIOR PANEL
ALL EXISTING PANELS ENTERED ?
ANY NON-EXISTENT PANELS ENTERED ?
WARNING
NO. COUPLED FLRS >1 ?
ZERO OUT MISSING FLOOR COORDINATES
ENTER COUPLED FLOORS LOOP
INPUT COORDINATES OF MISSING FLOORS
PANELS AT EDGES OF MISSING FLRS ?
INPUT AREAS AND FAILURE THRESHOLD OF OPENINGS
ARE WALLS AT OPNG LOCS ?
IDENTIFY FLOOR AREAS IN EACH ROOM ON EACH FLOOR
IDENTIFY COUPLED ROOMS ON ADJACENT FLOORS
COUNT COUPLED ROOMS
COMPUTE VOLUME OF EACH ROOM ON EACH FLOOR
COMPUTE SHOCK ARRIVAL TIMES TO EACH OPENING ON EACH FLOOR
ENTER TIME LOOP
COMPUTE EXTERIOR PRESSURE
HAS
ROOM

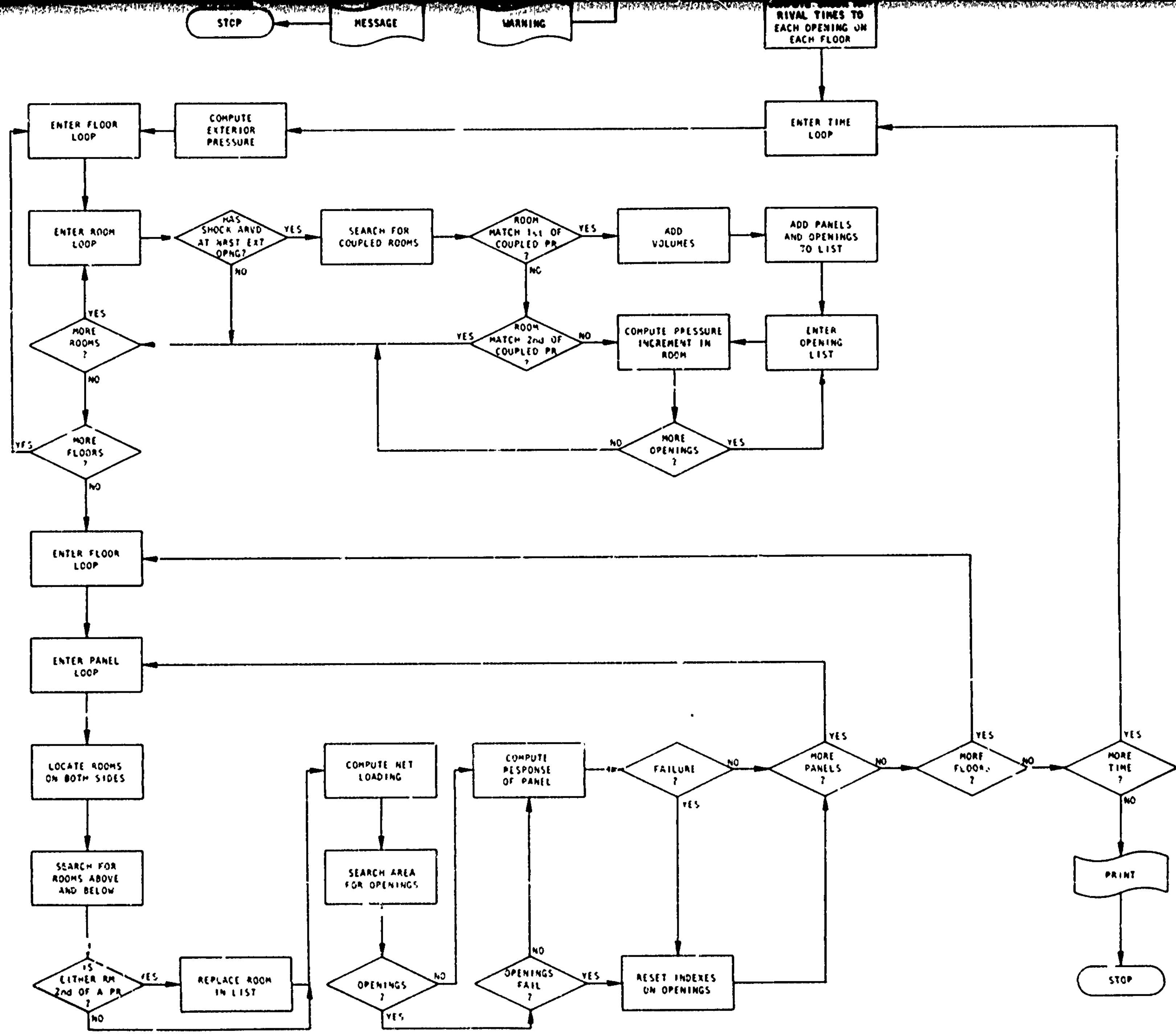


FIGURE 5 BUILDING SUBSYSTEM ORGANIZATIONAL FLOW CHART

IV ANALYSIS OF BASEMENT WALLS

The objective of this phase of the effort was to examine the blast resistance of exposed, reinforced concrete basement walls with door openings to determine the feasibility of retrofitting EOCs with blast doors. The primary purpose was to determine if reinforced concrete basement walls located in areaways of existing buildings could resist 10-psi blast overpressure.

Approach

In past studies, the collapse strength of blast loaded walls of existing buildings has been determined for various types and configurations of walls. Although mathematical models have been developed for walls with window openings, the procedures were not extended to include walls with door openings. Since there was insufficient time and funds to develop a generalized model and computer program for calculating the resistance and collapse of the wall configuration of interest, the following three-phase approach was used:

(1) A detailed yield-line analysis of several specific reinforced concrete walls with door openings was made to establish the static resistance over a limited range of wall widths.

(2) The computer programs developed for the building evaluation procedure for DCPA for analyzing the collapse of wall elements was used to generate resistance functions for walls without door openings. The results were then compared with those obtained from the yield-line analysis for walls with door openings to determine the feasibility of using the existing computer programs to simulate the dynamic response and

collapse of walls with door openings. If the resistances for the two wall types was found to be not comparable, then it would be necessary to hand calculate a resistance function for each wall case.

(3) An existing finite element computer program was used to analyze the static behavior for a few wall cases with door openings to determine if shear or stress concentrations could conceivably produce a wall failure not predictable by the other analyses.

Wall Design

The basement wall considered in this study was located in an open areaway such that the wall and door are fully exposed to the air blast effects. For simplicity, a standard door opening of 3 ft 8 in. wide by 6 ft 8 in. high was adopted; this is a two-unit-of-exit-width door opening as specified in Ref. 15. It was also assumed that the door was closed for all analyses and that it did not fail. The general layout of the basement wall analyzed is shown in Figure 6. As noted in Figure 6, it was assumed that the wall was bounded at the top and bottom by the first story and basement floors, and on the sides by the vertical areaway walls. The basement wall was continuous at the areaway wall intersection, and no interior walls abutted the basement wall in the vicinity of the areaway. The soil backfill adjacent to the areaway and basement walls extended to the first story level.

Since specific wall details were not provided, it was assumed that the basement walls were designed according to the 1963 ACI code (Ref. 16). Pertinent requirements of the code applicable to basement walls are:

- Area of horizontal reinforcing steel is not less than 0.0025 times the area of the reinforced section of the wall.
- Area of vertical reinforcing steel is not less than 0.0015 times the area of the reinforced section of the wall.

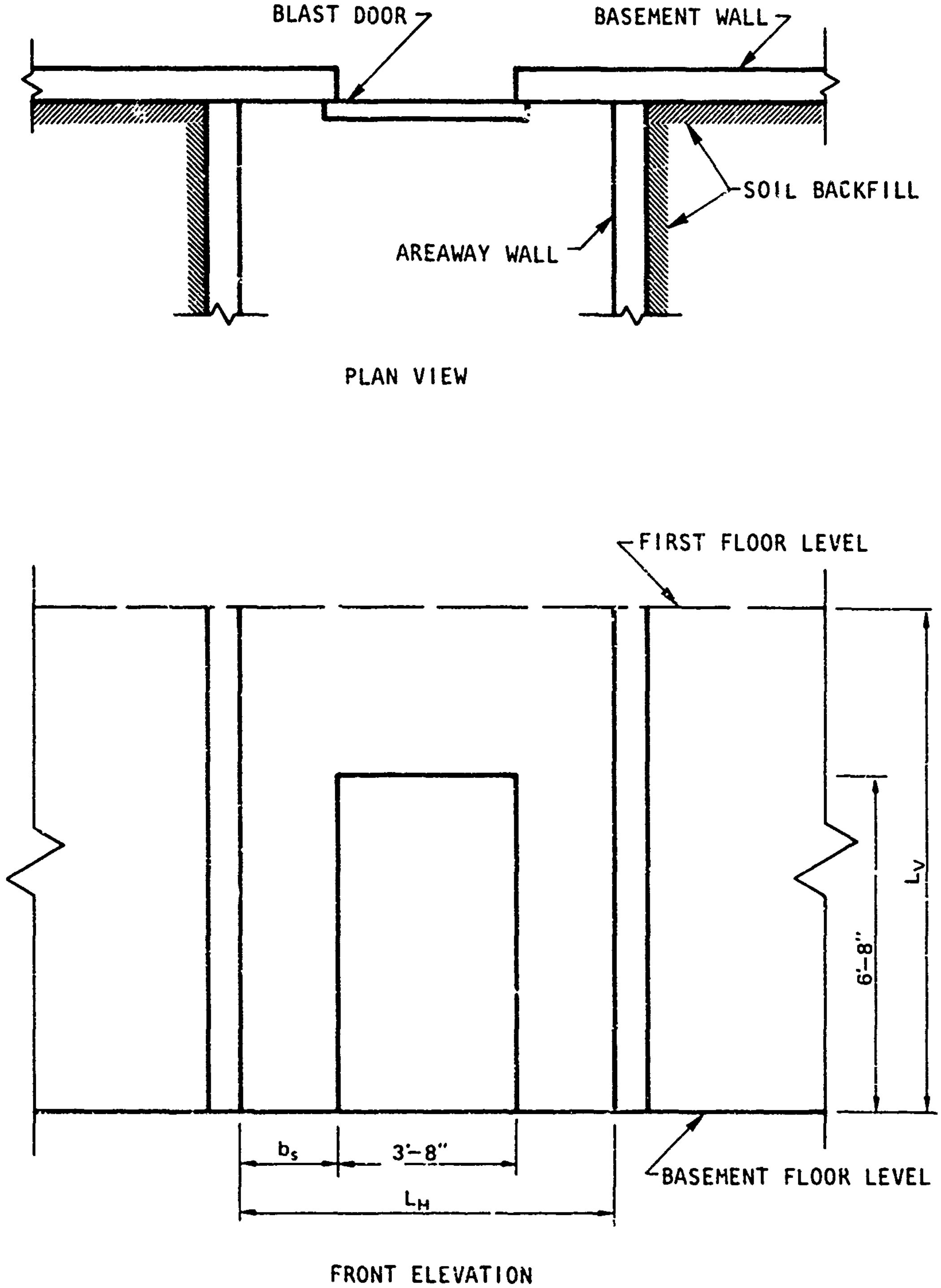


FIGURE 6 PLAN VIEW AND FRONT ELEVATION OF BASEMENT WALL USED IN THE ANALYSIS

- In addition to the above, two No. 5 bars are required around the door opening, and extending a distance of 24 in. beyond the opening.
- Minimum bar size is No. 3 at 18 in., center-to-center.
- Basement wall is assumed to be anchored to the floors and areaway walls with reinforcement equal to that in the wall.
- Minimum basement wall thickness is 8 in.

In addition, since the most efficient use of the reinforcing steel for the basement walls with soil backfill would dictate that the reinforcement be placed near the inside face of the wall, it was assumed that the reinforcement for the basement wall located in the areaway was also near the inside face.

Since it was assumed that the basement wall in the areaway was identical to that with soil backfill, the strength of a basement wall with minimum code reinforcement and with soil backfill was checked for adequacy as follows:

The lateral static soil pressure against the wall is

$p_h = K_o h \rho$,

where K_o = lateral soil coefficient (assumed as 0.30 for well-drained soil)

h = soil depth

ρ = unit weight of soil.

For height of wall, $L_v = 10.0$ ft,

$p_h = (.3)(10)(100) = 300$ psf (bottom of wall).

The maximum applied moment for a one-way wall simply supported at the top and bottom and with a triangular load function is

$M = 0.1283\ P_T L_v$,

where P_T = total applied load.

Therefore, the applied moment is equal to

$$M = (.1283)(300 \times \frac{10}{2})(10) = 1925 \text{ ft-lb/ft} \quad .$$

For a reinforced concrete section with tensile reinforcement only, the ultimate bending moment of the section is

$$M_u = \phi \left[A_s f_y (d - \frac{a}{2}) \right]$$

where $a = \dfrac{A_s f_y}{0.85 f'_c b}$.

For a reinforced concrete basement wall with minimum thickness, $t_w = 8$ in., the area of vertical reinforcement is

$$A_s = (8)(12)(.0015) = 0.144 \text{ sq in./ft of wall,}$$

$$A_s = \text{No. 3 @ 9 in.,}$$

and

$$d = 8 - (\frac{3}{4} + \frac{1}{2} \times \frac{3}{8}) = 7.06 \text{ in.}$$

For $f'_c = 3000$ psi and $f_y = 33{,}000$ psi

$$a = \frac{(.144)(33{,}000)}{(.85)(3000)(12)} = 0.1553,$$

and with a coefficient of flexure $\phi = 0.90$, the ultimate bending moment is therefore

$$M_u = (.90) \left[(.144)(33{,}000)(7.06 - \frac{.1553}{2}) \right] = 29{,}862 \text{ in.-lb/ft}$$

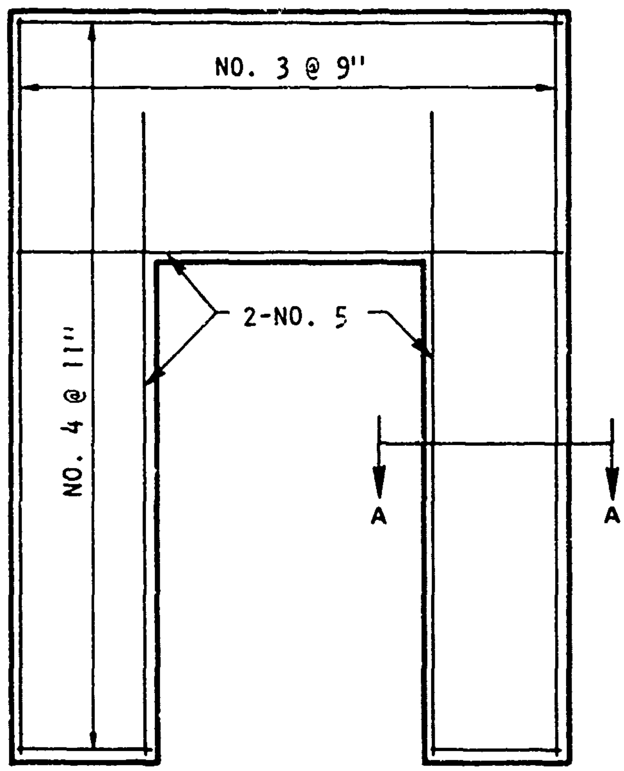
or

$$M_u = 2489 \text{ ft-lb/ft} \quad .$$

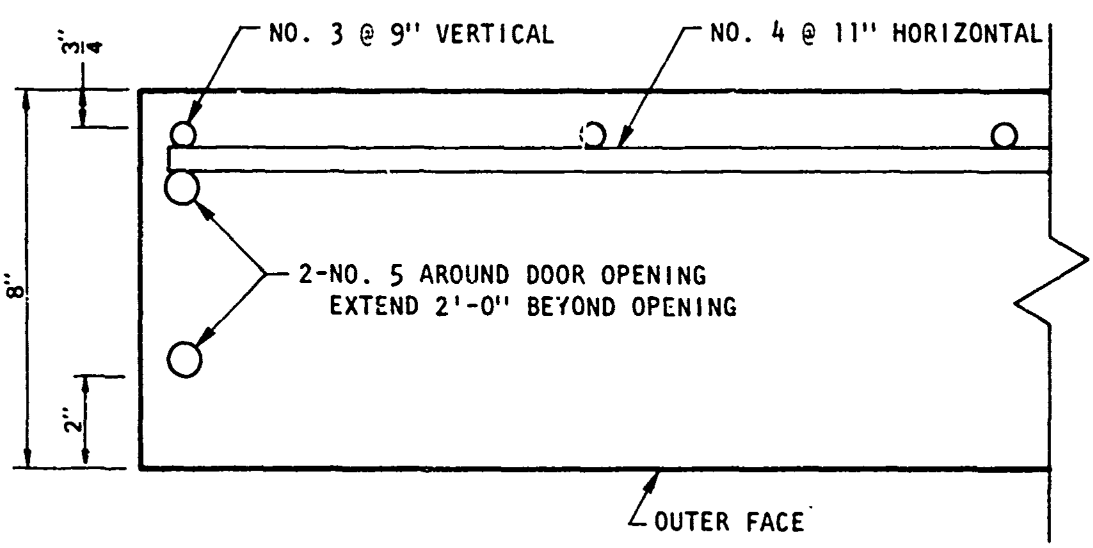
Since $M_u > M$, a fully buried, 10-ft-high by 8-in.-thick reinforced concrete basement wall with minimum code reinforcement is adequate to resist the pressure from a well-drained soil. Figure 7 illustrates the reinforcing steel details assumed for the 8-in.-thick basement wall used in the analysis.

Analysis

Various types of analyses were performed because a mathematical model that adequately represented the dynamic behavior and collapse of



ELEVATION OF BASEMENT WALL



SECTION A-A

FIGURE 7 REINFORCING STEEL DETAILS FOR 8-INCH THICK CONCRETE BASEMENT WALL USED IN ANALYSIS

basement walls with door openings had not been developed previously. The object was to use the available analytical tools to estimate with a good degree of confidence the collapse strength of basement walls in areaways without actually expending the time and effort required to develop a realistic mathematical model and writing the computer code.

Wall With Door Opening

The work-energy method from the yield-line theory for reinforced concrete slabs was used to calculate the flexural resistance for reinforced concrete walls with door openings. The method is outlined in Ref. 4, and will not be repeated here. The purpose of performing a limited number of yield-line analyses was to compare the resistance of walls with door openings with that of walls without door openings. If the resistance values for the two wall types were found to be approximately the same, then the available dynamic computer programs for wall elements could be used to provide interim collapse predictions for a variety of wall cases. However, if the resistances for the two wall types were found to be different, then the resistance values calculated for the walls with door openings could be used to perform a limited number of dynamic analyses.

The reinforcing steel details used for the analysis are shown in Figure 7. Since the calculation of the yield-line moments is a relatively tedious hand calculation requiring trial and error solutions, a minimum number of wall cases was considered. Therefore, only an 8-in.-thick wall with a height of 120 in. was treated; walls were analyzed with widths, L_w, of 92 in., 116 in., and 140 in. The calculated yield lines and resistance values for the three walls are shown in Figure 8.

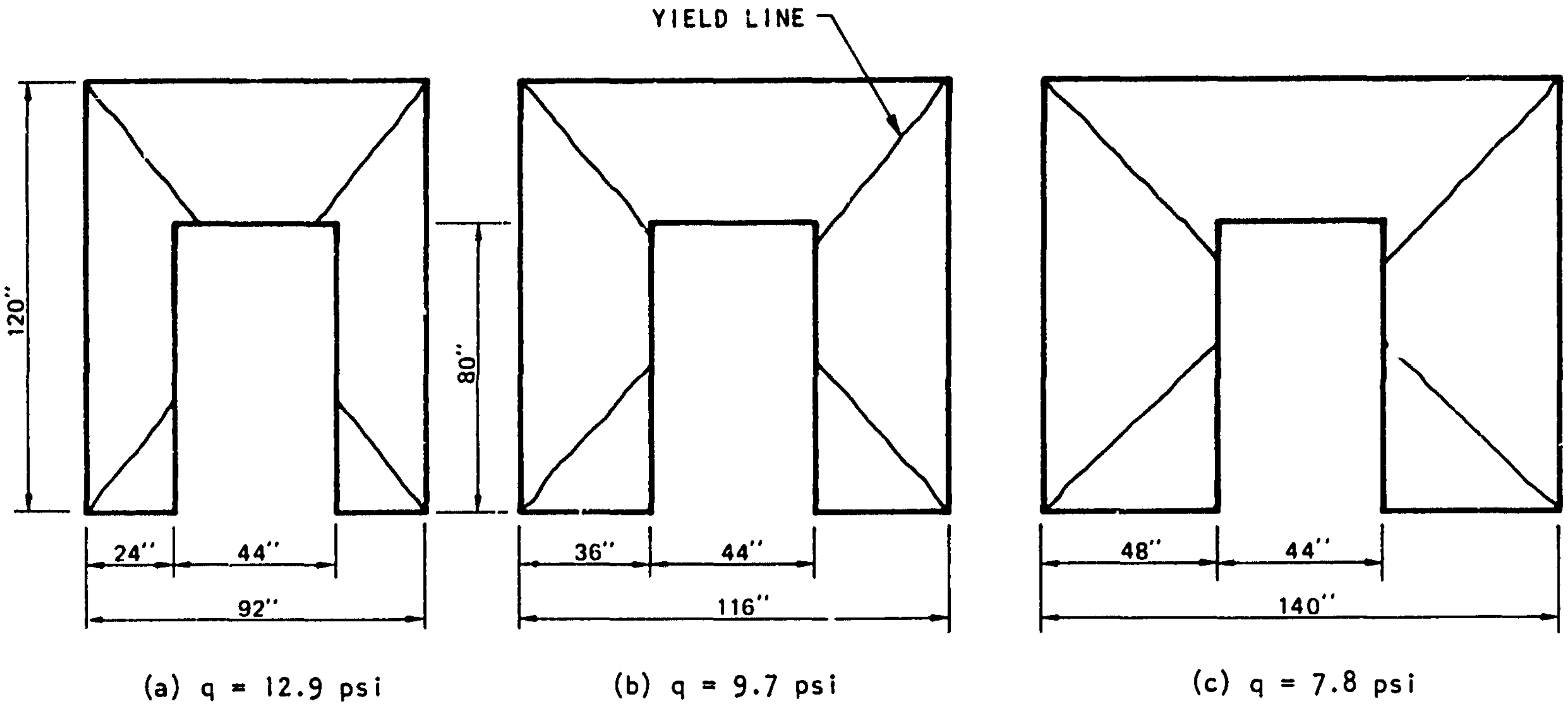


FIGURE 8 YIELD LINES AND RESISTANCE VALUES FOR REINFORCED CONCRETE WALLS WITH DOOR OPENING

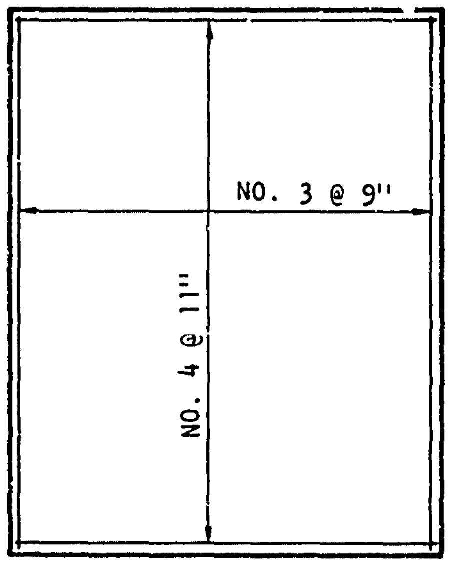
Wall Without Door Opening

A series of computer runs was made using the SRI programs developed previously for two-way action reinforced concrete walls (Ref. 4). The vertical load, P_v, in the plane of the wall was assumed to be zero; i.e., the wall was considered as a panel wall that did not carry any loads from the floor levels above. The horizontal and vertical reinforcement for the walls without door openings was the same as that for walls with door openings, except that for walls without door openings the two No. 5 bars around the opening shown in Figure 7 were deleted, as shown in Figure 9.

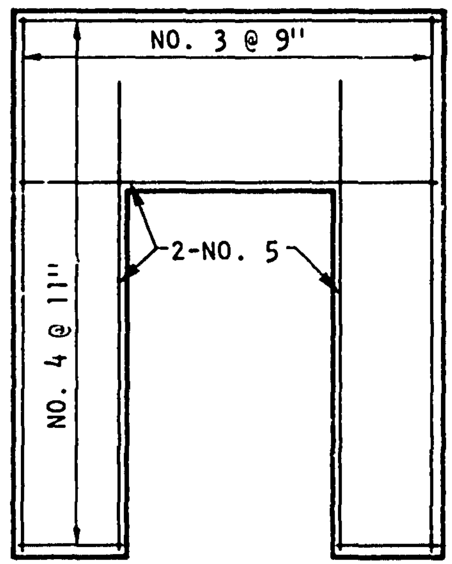
The values of the resistance for walls without door openings are plotted in Figure 10, where they are compared with the resistances calculated by the yield-line theory for walls with door openings. From the figure, it is apparent that the maximum resistance, q, for the two wall cases is approximately equal for the range of wall widths considered. Based on this limited study, it was assumed for the purpose of performing preliminary dynamic collapse predictions for reinforced concrete basement walls that the flexural resistances of wall with and without a door opening, and reinforced as shown in Figure 9, were equal.

To estimate the collapse of blast loaded basement walls with door openings, dynamic analyses were performed for a range of wall widths, two wall thicknesses, and two wall heights. The results of these analyses are shown in Figure 11. It should be noted that, since it was assumed that the basement walls were panel walls with $P_v = 0$, and did not arch, the curves can be considered as lower bound predictions for each wall type shown.

The collapse criterion adopted for walls in the evaluation procedure was based on the collapse of the wall in flexure; as discussed in Ref. 4, collapse is predicted as a result of excessive steel strain, instability, or an excessive ductility ratio. From studies made during the development



(a) Solid Wall Without Door Opening



(b) Wall With 3'-8" x 6'-8" Door Opening

FIGURE 9 WALLS ASSUMED AS EQUIVALENT FOR ANALYSIS PURPOSES

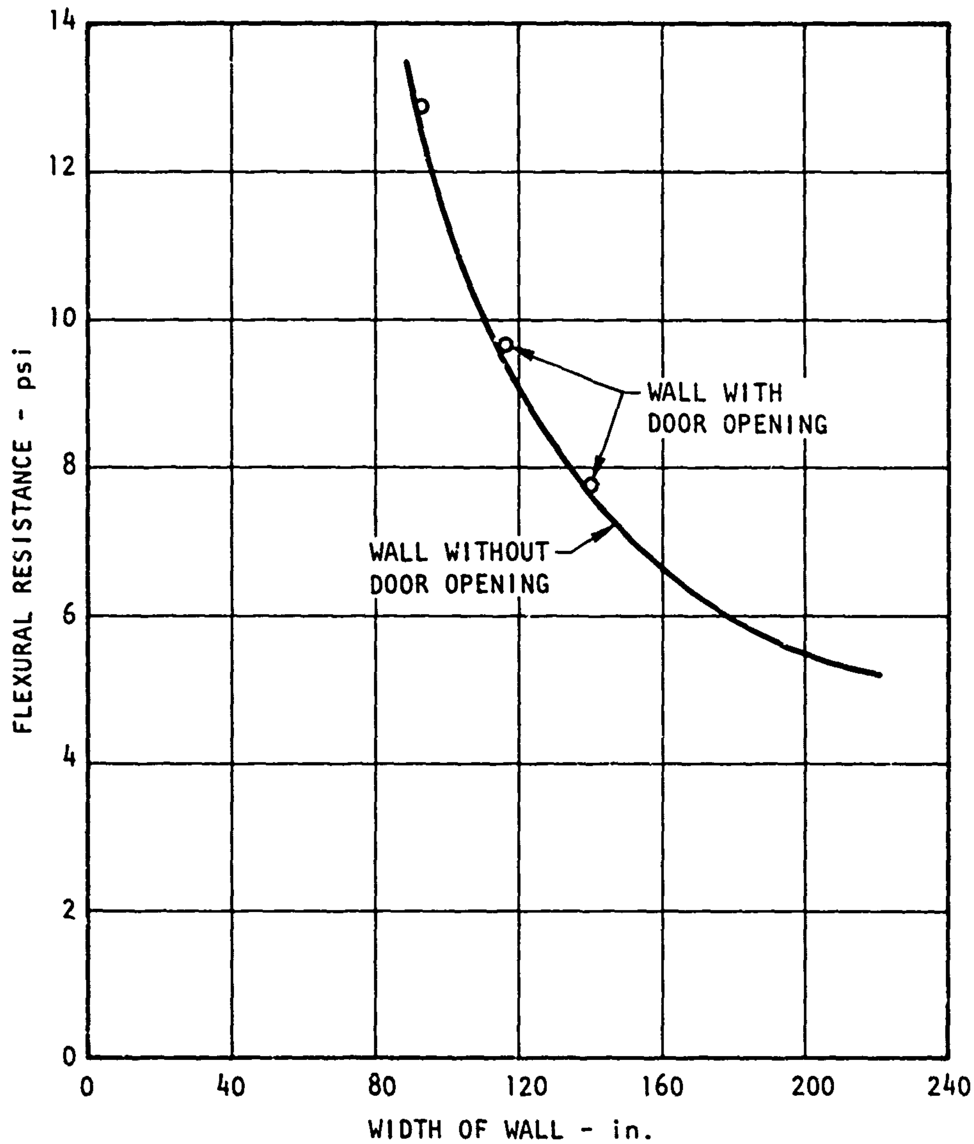


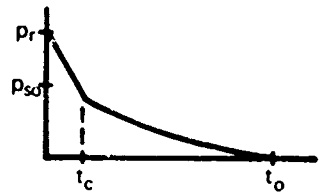
FIGURE 10 COMPARISON OF RESISTANCE VALUES FOR WALLS WITH AND WITHOUT A DOOR OPENING

WALL PARAMETERS

L_V = 96 in. and 120 in.
L_H = 92 in. to 240 in.
t_w = 8 in. and 12 in.
f'_{dc} = 3,750 psi
f_{dy} = 44,000 psi
p = 0.0025 A_c (horizontal)
p = 0.0015 A_c (vertical)
γ = 145 pcf
A_w = 0
Door opening: 3'-8" x 6'-8"
Support case: fixed four edges

LOAD PARAMETERS

W = 1 Mt
P_v = 0
S = 6.7 ft



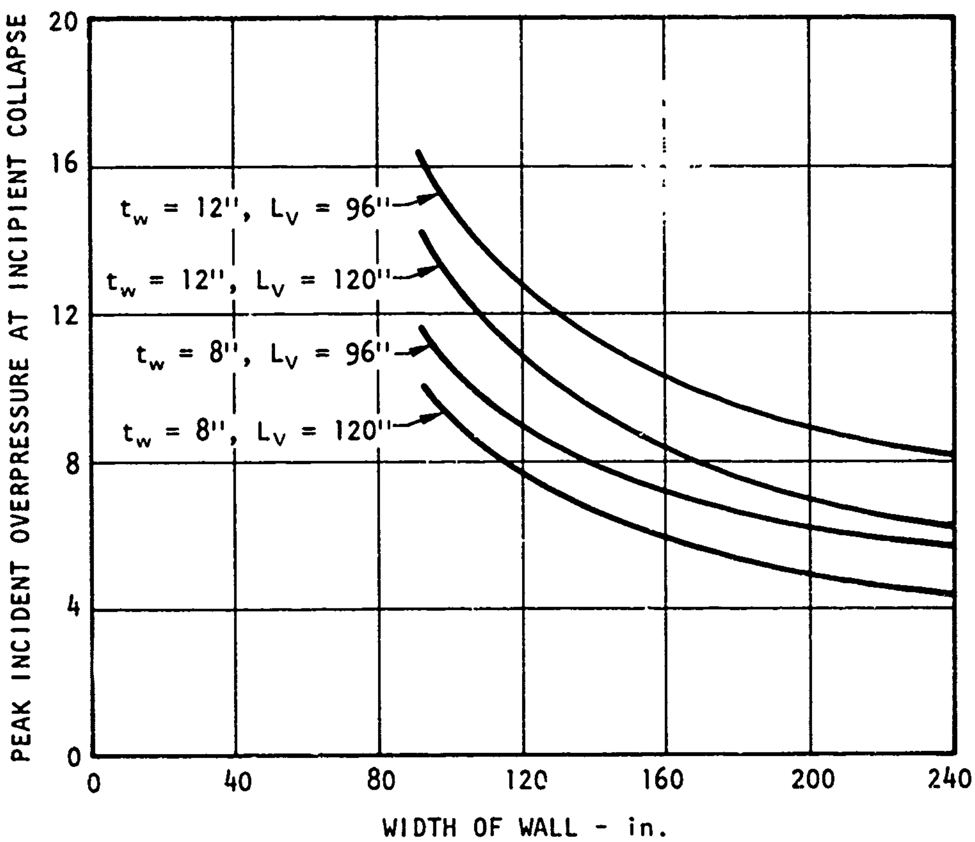
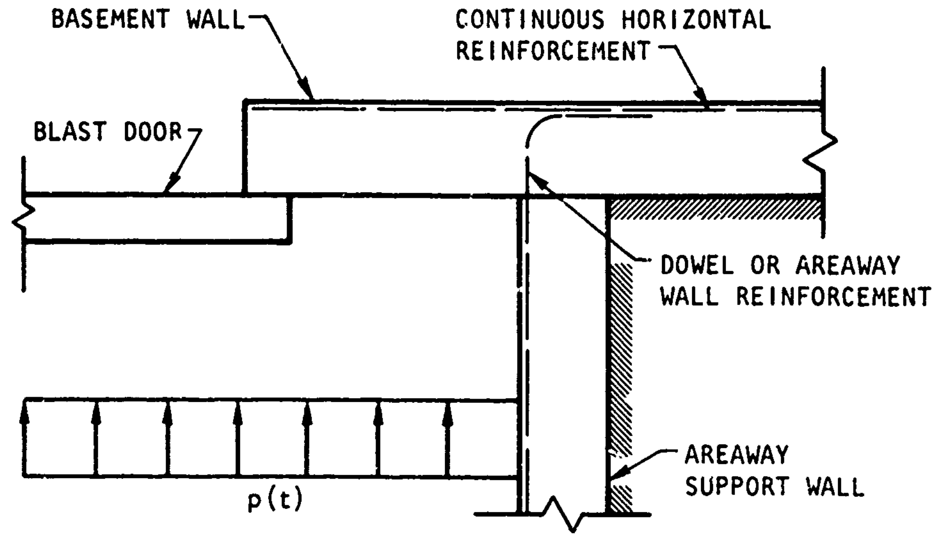


FIGURE 11 PEAK INCIDENT OVERPRESSURE AT INCIPIENT COLLAPSE VERSUS WALL WIDTH

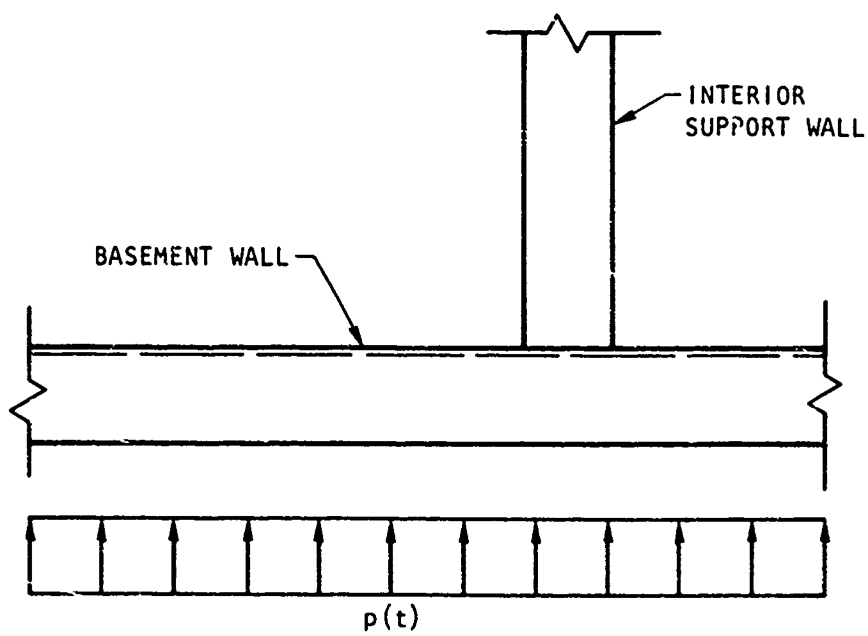
Two-Way Reinforced Concrete Basement Wall In Areaway

of the original wall evaluation procedure, it was determined that for lightly reinforced members with the usual type of supports, a shear failure would not be expected to occur, and if it did, it would not be expected to result in collapse of the wall. However, for the basement walls considered in this study, there were two factors that could influence the collapse mechanism assumed in the original procedure. First, the door opening could produce both higher local shears and stress concentrations than found in solid walls. Second, the reaction of the basement wall at the construction joint between the basement wall and the areaway support wall is opposite in direction to that usually encountered. That is, the reaction places the joint between the basement and areaway walls in tension; the areaway wall provides lateral support to the basement wall only through development of tensile forces in the reinforcing steel continuous through the joint shown in Figure 12a. This, of course, is opposite to the usual case where the lateral load on the wall forces the member to bear directly against its support as shown in Figure 12b.

There are two important implications as a result of the type of lateral support provided by the areaway walls that could influence the collapse predictions of the basement walls shown in Figure 11. First, the reinforcing steel between the basement and areaway walls could fail in tension, which would result in one-way wall action between floor levels rather than two-way action as assumed in the analysis. Second, under the lateral blast load tne basement wall cracks along all supports at small elastic deflections as a result of the negative moment developed. As illustrated in Figure 13a, the reinforcing steel is near the inside surface of the basement wall and the effective depth of the steel for resisting this negative moment is measured from the inside wall surface; for the assumed wall this distance, d, would be only 1-3/8 in. Because of the cracks at the support, the thickness of the concrete available for resisting the shear force is only equal to d, and therefore a shear

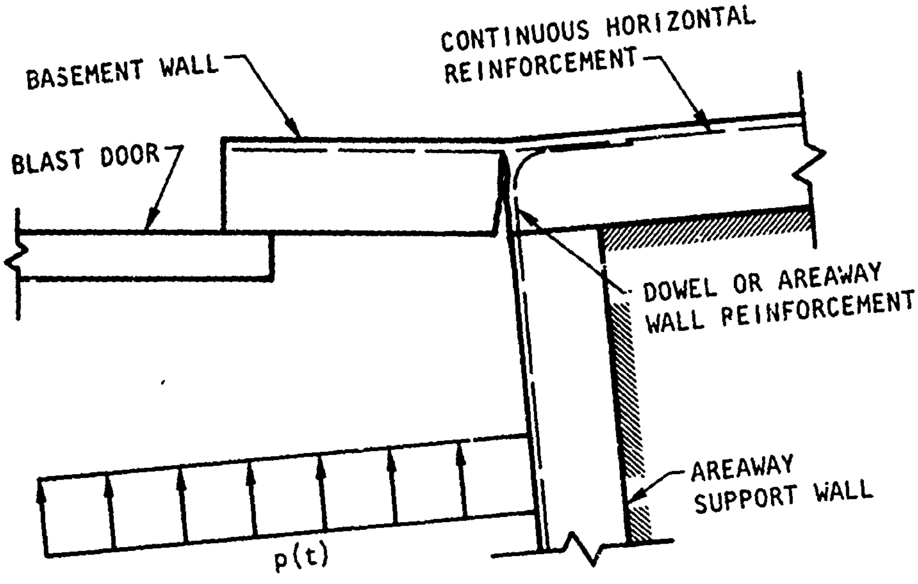


(a) Basement Wall in Areaway

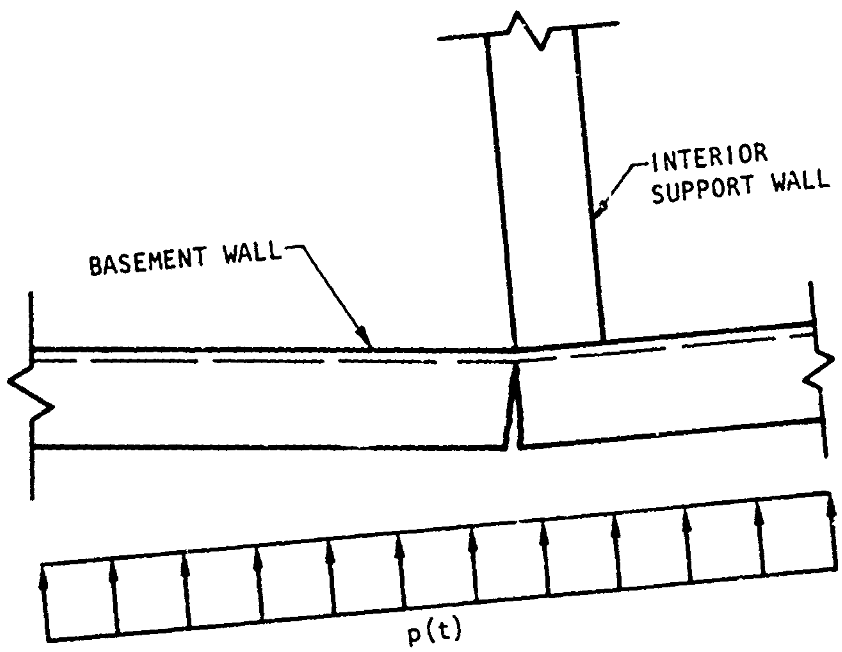


(b) Basement Wall With Interior Support Wall

FIGURE 12 PLAN VIEW OF CONSTRUCTION JOINT AT INTERSECTION OF BASEMENT AND SUPPORT WALLS



(a) Basement Wall in Areaway



(b) Basement Wall With Interior Support Wall

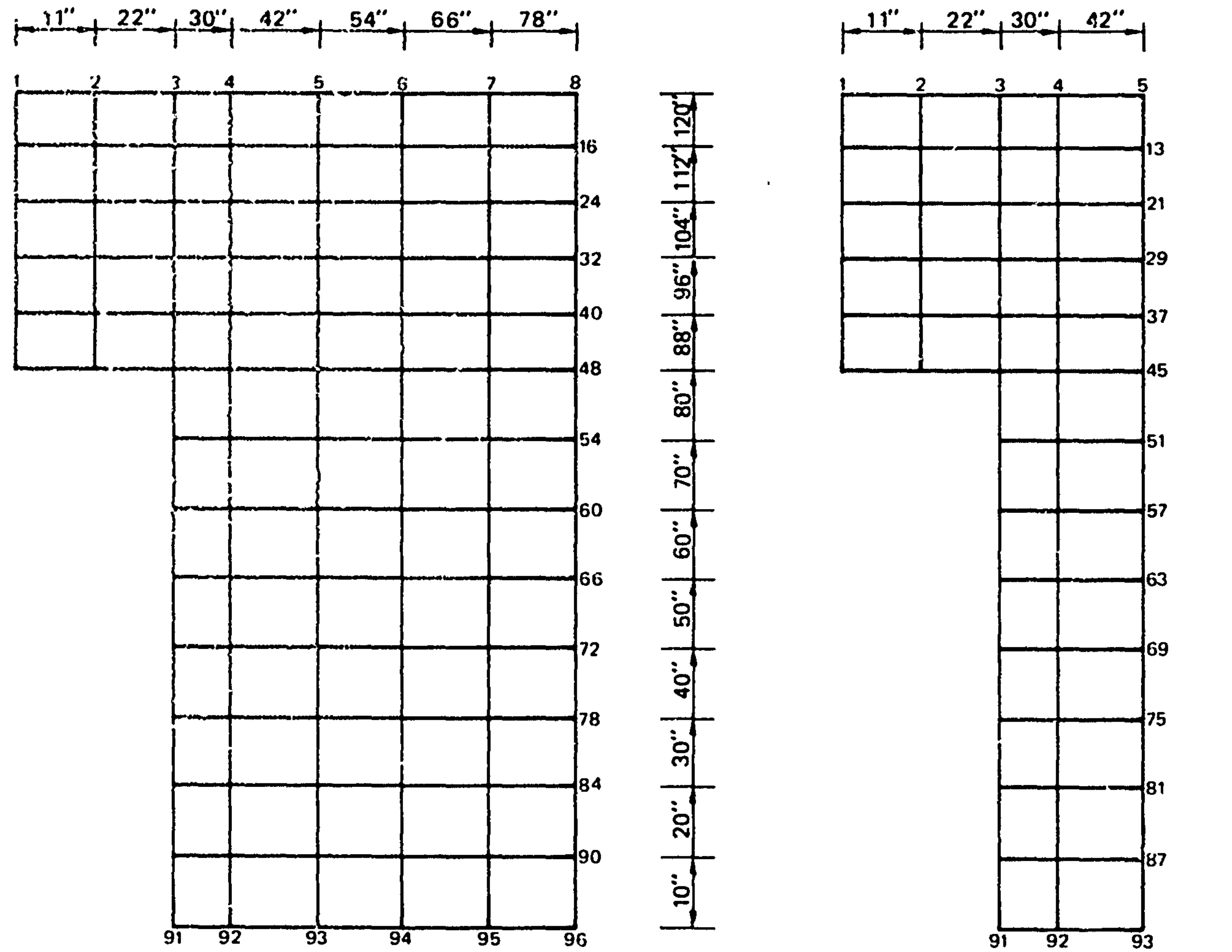
FIGURE 13 PLAN VIEW SHOWING CRACK AT CONSTRUCTION JOINT AT THE INTERSECTION OF BASEMENT AND SUPPORT WALLS

failure could occur early in the wall response. For the type of walls considered when developing the evaluation procedure, the reaction was assumed to act against the lateral interior support wall and a shear failure was not considered as a wall collapse mechanism. That is, a shear failure at the lateral support wall would precipitate a tensile membrane mode of response in the basement wall, rather than a wall collapse, and the reactive forces would be transferred to the support by tensile action of the continuous reinforcement; this is illustrated in Figure 13b. For a basement wall located in an areaway, a shear failure in the wall at the construction joint between the basement and areaway walls would result in rupturing of the concrete and tearing out of the continuous reinforcing steel in the basement wall; the small concrete cover over the reinforcement shown in Figure 13a could not be expected to resist the reactive forces of the basement wall.

Since the mathematical models developed for the evaluation procedures could not be used to investigate the details of localized internal stresses and reactions for the complex door opening wall geometry, an available static finite element computer program was used to estimate probable failure modes.

Finite Element Wall Program

Although the available finite element program is a powerful analytical tool, it is limited to static, elastic structural systems. Therefore, the primary value of the results for this study was to provide a basis for estimating possible collapse mechanisms; the results were of only limited quantitative value. The two basic wall configurations analyzed are illustrated in Figure 14; because of symmetry, it was only necessary to consider one-half the wall. The wall model consisted of an assemblage of plate elements, and only the support nodes are numbered on the figure. The useful output information included the deflections, internal loads,



(a) One-Half Wall, L_H = 156 in.

(b) One-Half Wall, L_H = 84 in.

FIGURE 14 WALL WITH DOOR OPENING SHOWING FINITE PLATE ELEMENTS AND NODES

and extreme fiber stresses in the plates, and the reactions at each support node. For this exercise, only an 8-in.-thick wall with a 120-in. height was considered. The walls were analyzed for a static lateral load of 10 psi applied uniformly to the wall and door; the door load was distributed to the wall nodes adjacent to the opening.

The primary reason for conducting the finite element analysis was to provide more detailed information about the reactions at the construction joint formed by the intersection of the basement and areaway walls than was available from the other analyses. For the wall with L_u = 156 in., the following values for the basement wall reactions at the basement/areaway wall joint were obtained for the nodes shown in Figure 11:

Node	Reaction, lb
16	1,904
24	2,915
32	3,801
40	-3,165
48	11,785
54	6,125
60	6,079
66	6,027
72	5,684
78	5,081
84	1,194
90	2,680

The maximum reaction predicted is 11,785 lb at node 48; next is 6,125 lb at node 54. Since the actual wall had continuous support rather than point support at each node, it is appropriate to average the reaction between two adjacent nodes. Therefore, the maximum average applied shear along the basement/areaway wall joint is

$$V = \frac{11,785 + 6,125}{(2)(10)} = 896 \text{ lb/in.}$$

To determine whether this magnitude of applied shear would result in a shear failure in the basement wall, it was necessary to calculate the shear resistance of the wall. From Ref. 7, the unit shear resistance at the support of a reinforced concrete member is

$$(v_c)_s = \frac{2.28\sqrt{f'_c}}{1-2d/L} + \frac{3000p}{1-d/L} \leq \frac{3.5\sqrt{f'_c}}{1-2d/L} .$$

For the basement wall, the horizontal reinforcement is

$$A_s = 0.240 \text{ sq in./ft},$$

and d = 1.38 in. for a racked concrete section, therefore

$$p = \frac{0.240}{(12)(1.38)} = 0.01449.$$

Substituting these quantities into the above equation, the unit shear is

$$(v_c)_s = \frac{2.28\sqrt{3000}}{1-\frac{(2)(1.38)}{1.56}} + \frac{(3000)(.01449)}{1-\frac{1.38}{156}} = 171 \text{ psi}.$$

Since the total shear resistance at the support would be

$$(V_c)_s = (v_c)_s bd,$$

then

$$(V_c)_s = (171)(1)(1.38) = 236 \text{ lb/in.}$$

This value is, of course, much less than the shear force of 896 lb/in. resulting from a uniform static load of 10 psi. For estimating purposes only, if it is assumed that the dynamic shear resistance is 25 percent greater than the static, and that a dynamic load factor (DLF) of 1.15 is appropriate for the load type, then a rough estimate of the level of the blast load that would result in a shear failure in the wall would be

$$p_{so} \approx \frac{(236)(1.25)(10)}{(1.15)(896)} \approx 2.9 \text{ psi}.$$

For the basement wall with L_u = 84 in., two wall cases were considered; (1) simply supported on four edges, and (2) fixed on four edges. The values of the reactions along the basement/areaway wall joint for the simply supported wall with a 10-psi static load were as follows:

Node	Reaction, lb
13	1,520
21	2,318
29	3,087
37	-3,839
45	7,764
51	3,924
57	3,820
63	3,976
69	4,027
75	3,904
81	3,531
87	2,467

Using the same method as before for two adjacent nodes, the predicted maximum average shear along the basement/areaway wall joint is

$$V = \frac{7764 + 3924}{(2)(10)} = 584 \text{ lb/in.}$$

Again, a rough estimate of the blast overpressure that would result in a shear failure in the basement wall would be

$$p_{so} \approx \frac{(236)(1.25)(10)}{(1.15)(584)} \approx 4.4 \text{ psi.}$$

Based on the above rough estimates for 8-in.-thick reinforced concrete walls with door openings, it could be concluded that a shear failure will occur at blast overpressures less than 5 psi if the horizontal distance from the edge of the door opening to the areaway wall is greater than about 18 in., i.e., for $L_u \geq 80$ in. However, since this estimate is based on a cracked concrete section, it is of interest to examine the effect on the strength of the wall of the concrete cracking along the supports.

As the exposed horizontal distance between the edge of the door opening and the areaway support wall is increased, the probability of a shear failure occurring in the basement wall is also increased. For example, if the horizontal distance is equal to the wall thickness,

t_w = 8 in. (L_H = 60 in.), then the full thickness of the concrete wall section is effective in resisting the applied shear force because the modulus of rupture of the concrete has not been exceeded and the concrete section is uncracked. Since the shear resistance for this case is much greater than the applied shear, the wall would not be expected to experience a shear failure. As the width of the wall is increased to 84 in., the values of the reactions and moments along the basement/areaway joint for an 8-in.-thick concrete wall fixed on four edges and with a 10-psi static load are as follows:

Node	Reaction, lb	Moment in.-lb
13	-26	1,149
21	1,187	10,813
29	1,738	20,043
37	2,726	37,845
45	5,031	55,746
51	3,786	49,166
57	4,076	52,550
63	4,267	54,022
69	4,329	52,165
75	4,103	45,468
81	3,125	31,006
87	167	7,190

The maximum moment predicted for two adjacent nodes is 52,550 in.-lb for node 57; next is 54,022 in.-lb for node 63. Therefore, the maximum average moment along the basement/areaway wall joint is

$$M = \frac{52,550 + 54,022}{(2)(10)} = 5329 \text{ in.-lb/in.}$$

To estimate if the wall cracks under the applied moment, it is necessary to calculate the resisting moment for the uncracked wall section. For a linear relationship between stress and strain across the section of the wall, the maximum resisting moment is equal to

$$M_u = \frac{f_r b t_x^2}{6} .$$

For

$$f_r = 8\sqrt{f'_{dc}} \ ,$$

$$M_u = \frac{(8)\sqrt{3750}(1)(8)^2}{6} = 5226 \text{ in.-lb/in.} \ ,$$

which is approximately equal to the applied moment. Therefore, an 8-in.-thick concrete wall with a horizontal distance between the edge of the door and the areaway support wall of about 20 in. (L_u = 84 in.) would be expected to crack and experience a shear failure along the basement/areaway wall joint at a blast overpressure level somewhat less than 10 psi. This, of course, indicates a much greater blast strength for the uncracked wall case than was estimated above for the cracked wall case.

One-Way Reinforced Concrete Wall (Without Arching)

As discussed in the previous subsection, under dynamic load the initial shear failure in an 8-in.-thick, two-way reinforced concrete basement wall located in an areaway would occur at the points of maximum shear along the joint between the basement and areaway walls at relatively small wall deflections. The shear failure would result in the initiation of one-way wall action (i.e., the lateral support of the areaway wall would be lost) at a time shortly after arrival of the blast wave. However, as noted in the above tabulations for the nodes shown in Figure 14, the shear forces developed as a result of a 10-psi uniform static load decreased in magnitude from a maximum in the center portion of the wall to a minimum near the top and bottom supports; in particular, the shear forces at the nodes above the level of the door opening are much less than the maximum shear values. It is therefore reasonable to assume that under blast loading the one-way action wall without arching will have an effective span somewhat less than the total height of the basement wall. Therefore, for this study, the effective wall height for

for one-way action was assumed equal to the height of the door opening. The collapse overpressure was obtained for walls with the following properties and load conditions:

L_V = 80 in.

L_H = 92 to 360 in.

t_w = 8 in.

f'_{dc} = 3,750 psi

f_{dy} = 44,000 psi

p = 0.0015 A_c (vertical)

γ = 145 pcf

P_v = 0

Support case: one-way propped cantilever

S = 6.7 ft

W = 1 Mt

The collapse of these basement walls is predicted to occur at a blast overpressure of approximately 4.5 psi for all wall widths from L_H = 92 in to 360 in. For comparison, the collapse overpressure was also obtained for a 12-in.-thick reinforced concrete basement wall with the same properties as for the above 8-in. wall. The predicted collapse overpressure for the 12-in.-thick wall was found to be 9.2 psi for the same range of wall widths.

One-Way Concrete Wall (With Arching)

For a frame structure, it is possible that one-way arching, rather than one-way flexure, may occur in the basement wall subsequent to a shear failure at the basement/areaway wall construction joint. Therefore, calculations were performed to determine the blast strength of one-way arching walls. Since arching walls develop considerable more resistance than similar nonarching walls, it was felt to be more meaningful to use

the full height of arching walls in the analysis, rather than the height of the door opening as was done for nonarching walls. The collapse overpressure was obtained for a wall with the following properties and load conditions:

L_ℓ = 120 in.

L_w = 92 to 360 in.

t_w = 8 in.

f'_c = 3,750 psi

γ = 145 pcf

Support case: one-way arching

S = 6.7 ft.

W = 1 Mt

The collapse of these basement walls is predicted to increase from a blast overpressure level of 6.9 psi for L_w = 92 in. to 10.1 psi for L_w = 360 in. The results of the analyses for both the one-way concrete walls with arching and without arching are shown in Figure 15.

Summary and Discussion

The primary purpose of this effort was to examine the dynamic response of conventional reinforced concrete basement walls located in areaways, and determine if such walls can resist a 10-psi blast overpressure. Since an adequate analytical model for predicting the collapse of basement walls with door openings was not available, it was necessary to perform several types of analyses so as to make a realistic estimate of the collapse strength of the walls. To provide uniformity for the various analyses, a standard basement wall with door opening was designed in accordance with the 1963 ACI code for reinforced concrete.

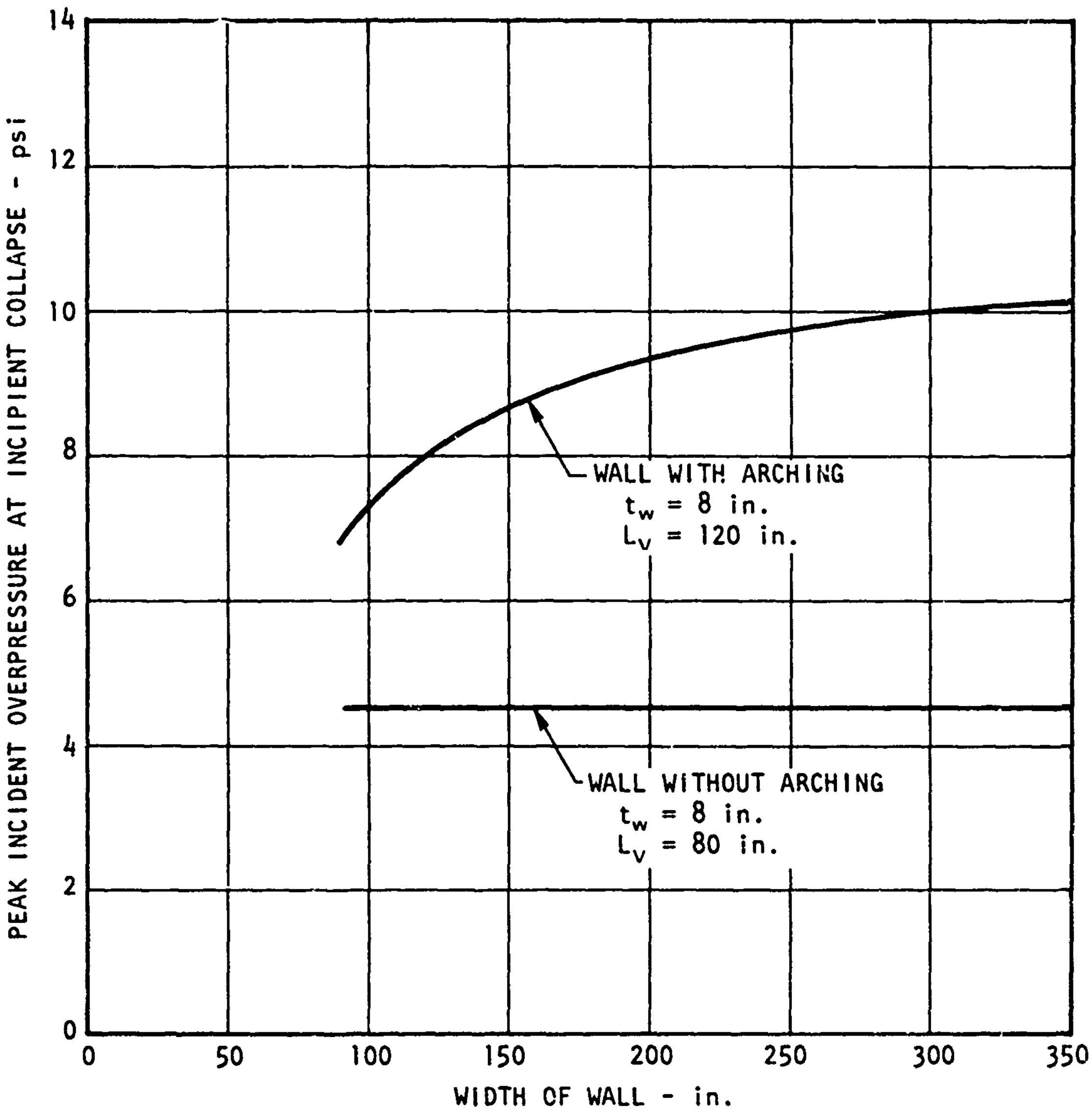


FIGURE 15 PEAK INCIDENT OVERPRESSURE AT INCIPIENT COLLAPSE VERSUS WALL WIDTH

One-Way Reinforced Concrete Basement Wall Without Arching
One-Way Concrete Basement Wall With Arching

An initial static analysis was made to compare the flexural resistances of two-way reinforced concrete walls with and without door openings. The results of this analysis (Figure 10) indicated that the flexural resistances of the two walls shown in Figure 9 were approximately equivalent. It was therefore warranted to use an available computer program to perform dynamic analyses of walls without door openings, and then to use these results for estimating the collapse overpressure of basement walls with door openings. The predicted collapse overpressures for two-way walls without door openings are shown in Figure 11 for 8- and 12-in.-thick reinforced concrete walls with wall heights of 96 and 120 in.

However, although the results of this analysis appeared reasonable, there was some co· ern because the available analytical model could not provide sufficient detailed information on the effect of the complex door opening geometry on the response of the wall. Therefore, an available static finite element computer program was used to analyze an 8-in.-thick two-way wall. The results for a 10-psi uniform lateral static load indicated that a shear failure was probable at the construction joint between the basement and areaway walls shown in Figure 12a. From the analysis of two walls with different widths, it was concluded that a shear failure would occur at relatively low overpressure levels if the areaway wall was located greater than abc · 20-in. horizontal distance from the edge of the door opening. However, a shear failure in the basement wall at the basement/areaway wall joint does not necessarily result in collapse of the basement wall, since the wall may still resist the applied blast forces through one-way flexural or arching action between top and bottom supports subsequent to the shear failure and loss of side supports.

To determine the effect of a shear failure at the basement/areaway wall joint on the collapse strength of two-way walls, dynamic analyses

were performed for one-way basement walls, both with and without arching. The results of the analyses are indicated in Figure 15, where it can be noted that 8-in.-thick reinforced concrete basement walls without arching are predicted to collapse at less than 5-psi blast overpressure. Although the predicted collapse overpressure for arching walls is much greater than for nonarching walls, for most of the wall widths examined the strength of arching walls is less than the 10-psi blast overpressure criterion. It should be mentioned that these results apply to the minimum thickness reinforced concrete basement wall, which has the minimum area of steel reinforcement permitted by the 1963 ACI building code for reinforced concrete.

Conclusions

From the various analyses performed, a few general conclusions can be made concerning the collapse of blast loaded reinforced concrete basement walls with door openings and located in areaways. First, for reinforced concrete walls 8-in. thick or thicker, and not over 10-ft high, it is probable that the wall strength of the weakest code-designed wall is sufficient to resist a 10-psi blast loading if the horizontal distance from the edge of the door opening to the areaway support wall is less than approximately 20 in. (L_w = 84 in.).

Second, for 8-in.-thick walls with horizontal distance between door opening and areaway wall greater than about 20 in., it will be necessary to strengthen the wall in the vicinity of the door opening so as to upgrade the wall to the 10-psi blast overpressure level.

Third, for reinforced concrete basement walls 12-in. thick or thicker, the blast strength can be expected to be approximately equal to or greater than the 10-psi blast overpressure criterion for all wall conditions.

Appendix A

LISTINGS OF COMPUTER PROGRAMS

Appendix A

LISTINGS OF COMPUTER PROGRAMS

Introduction

This appendix contains a printout of the listing for each program developed for DCPA for analyzing the dynamic response and collapse of walls and floor systems of existing buildings.

The programs were coded in FORTRAN and run on United Computing Systems, Inc., commercial time-sharing CDC 6400 computer (System UCS-VI); running on other systems may require minor modifications to the programs. For convenience and ease of use during the research effort, as well as by others later, the programs were written in an interactive or conversational mode.

To reduce the size of the computer central memory required, and thereby reduce the cost of running the programs, the Link Mode or chaining technique was used for the larger programs. Chaining has the advantage of reducing the overall cost of running programs, but a slightly more complicated technique is required to compile the programs in preparation for execution. Half of the programs were developed as chained programs.

Also included in this appendix are short summaries describing the function of each of the following eight programs:

- UNREINF, Unreinforced masonry wall without arching, see page 63
- ARCHING, Unreinforced masonry wall with arching, see page 81
- RCWALL, Reinforced concrete wall,* see page 95

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* Link Mode or chained program.

- RCSLAB, Reinforced concrete slab,* see page 115
- RESTRAN, Restrained reinforced concrete slab, see page 133
- RCBEAM, Reinforced concrete support beam,* see page 147
- STBEAM, Steel support bean,* see page 165
- FLAT, Flat slab or flat plate, see page 181.

Following the summaries are the listings of the programs.

Summary of Computer Programs

Program UNREINF

Analyzes one-way and two-way unreinforced masonry walls (exterior or interior) without arching for a given load, or solves for incipient collapse load. Window openings may be included. Load types include: idealized blast loading (front, side, or rear face) with or without room filling; triangular load; rectangular load; URS tunnel loading; arbitrary load shape. Modulus of rupture and clearing distance may be randomly varied (normal distribution).

Subroutines:	Main Routine	COEF
	FORCE	TRANS
	FILL	WINDOW
	RESIST	RANDOM

Program ARCHING

Analyzes one-way and two-way unreinforced masonry walls (exterior or interior) with arching for a given load, or solves for incipient collapse load. Window openings may be included. Load types include: idealized blast loading (front, side, or rear face) with or without room filling; triangular load; rectangular load; URS tunnel loading; arbitrary load shape. Ultimate compressive strength, modulus of elasticity, and clearing distance may be randomly varied (normal distribution).

---

* Link Mode or chained program.

Subroutines:	Main Routine	RESIST
	FORCE	WINDOW
	FILL	RANDOM

<u>Program RCWALL</u>

Analyzes one-way and two-way reinforced concrete walls (exterior or interior) for a given load, or solves for incipient collapse load. Window openings may be included. Load types include: idealized blast loading (front, side, or rear face) with or without room filling; arbitrary load shape. Dynamic yield strength of reinforcement steel and clearing distance may be randomly varied (normal distribution).

Subroutines:	RCWALL1	RESIST
	WINDOW	MOMENT
	RCWALL2	COEF
	FORCE	TRANS
	FILL	RANDOM

<u>Program RCSLAB</u>

Analyzes one-way and two-way reinforced concrete floor slabs for a given load, or solves for incipient collapse load. Tensile membrane resistance may be included. Dynamic reactions may be output to a data file for use in analyzing support beams. Load types include: idealized blast loading (top face) with rise time equal to time required for blast wave to travel across short span; room filling pressure resulting from idealized blast loading; arbitrary load shape. Dynamic yield strength of reinforcement steel and clearing distance (for room filling load) may be randomly varied (normal distribution).

Subroutines:	RCSLAB1	RESIST
	COEF	MOMENT
	RCSLAB2	TRANS
	FORCE	RANDOM
	FILL	

Program RESTRAN

Analyzes two-way reinforced concrete floor slabs with edges restrained against lateral movement for a given load, or solves for incipient collapse load. Both compressive and tensile membrane behavior are included. Load types include: idealized blast loading (top face) with rise time equal to time required for blast wave to travel across short span; room filling pressure resulting from idealized blast loading; arbitrary load shape. Yield strength of reinforcement steel, concrete compressive strength, and clearing distance (for room filling load) may be randomly varied (normal distribution).

Subroutines:	Main Routine	MOMENT
	FORCE	TRANS
	FILL	RANDOM
	RESIST	

Program RCBEAM

Analyzes reinforced concrete beams (rectangular or T-beam) for a given load, or solves for incipient collapse load. Tensile membrane resistance may be included. Load types include: dynamic reactions from slab analysis (see RCSLAB); idealized blast loading acting on beam and area of slab supported by the beam with rise time equal to time required for blast wave to travel length of the beam; room filling pressure resulting from idealized blast loading acting on beam and area of slab supported by the beam; arbitrary load shape. Dynamic yield strength of reinforcement steel and clearing distance (for room filling load) may be randomly varied (normal distribution).

Subroutines:	RCBEAM1	RESIST
	RCBEAM2	MOMENT
	FORCE	COEF
	FILL	TRANS
		RANDOM

Program STBEAM

Analyzes structural steel beam (wide flange may include bottom steel cover plate and/or composite action with slab) for a given load, or solves for incipient collapse load. Load types include: dynamic reactions from slab analysis (see RCSLAB); idealized blast loading acting on beam and area of slab supported by the beam with rise time equal to time required for blast wave to travel length of the beam; room filling pressure resulting from idealized blast loading acting on beam and area of slab supported by the beam; arbitrary load shape. Dynamic yield strength of structural steel, dynamic yield strength of reinforcement steel (composite beam), and clearing distance (for room filling load) may be randomly varied (normal distribution).

Subroutines:	STBEAM1	RESIST
	STBEAM2	COEF
	FORCE	TRANS
	FILL	RANDOM

Program FLAT

Analyzes reinforced concrete flat slab floor system or flat plate floor system for a given load, or solves for incipient collapse load. Tensile membrane resistance may be included. Load types include: idealized blast load (top face) with rise time equal to the time required for blast wave to travel across span (slab assumed to be square); room filling pressure resulting from idealized blast loading; arbitrary load shape. Dynamic yield strength of reinforcement steel and clearing distance (for room filling load) may be randomly varied (normal distribution).

Subroutines:	Main Routine	RESIST
	FORCE	MOMENT
	FILL	RANDOM

UNREINF

Unreinforced Masonry Wall Without Arching

PROGRAM UNREINF

```
      PRØGRAM JIMBØC(INPUT,ØUTPUT,TAPE1=ØUTPUT)
C:  THIS RØUTINE IS THE CØNTRØLLING RØUTINE FØR THE PRØGRAM USED
C:  IN THE ANALYSIS ØF ØNE-WAY ØR TWØ-WAY ACTIØN WALLS.
C
      CØMMØN Y(100),YU,YFAIL,Q,QU,AREA,ZMASS,ZKLM,VH1,VH2,VV1,VV2
      CØMMØN KWALL,KINC,KRF,KRAND,I,ICASE,FU,VFAIL,FR,FPM,EM,FDY
      CØMMØN FDC,D(4),LDTYPE,PEXT,PF,PSØ,PDØ,PC,TC,TO,PØ,TIME,L,S
      CØMMØN /RAND/  TIMEC,IWALL
      DIMENSIØN A(100),V(100),T(100),VV(100),VH(100),
     +  PEX(100),PIN(100),PN(100)
C
C:  READ TITLE AND CØNTRØL PARAMETERS
5     PRINT 67
      READ 68,TITLE
      PRINT 95
      READ,KWALL KINC,LDTYPE,KRF,KRAND
      DELAY=0
      VFAIL=1E10
      CALL RESIST(1)
      CALL FØRCE(1)
      IF(KRF.EQ.0)GØTØ 12
      CALL FILL(PINT,1)
12    IF(KWALL.EQ.0)GØTØ 14
      PRINT 86
      READ,DELAY
      DELAY=DELAY/1000.0
14    IF(KRAND.NE.1)GØTØ 35
      CALL FØRCE(4)
      CALL RANDØM(1)
34    CALL RANDØM(2)
35    CALL RESIST(3)
C
C: MINIMUM, MAXIMUM, AND STARTING VALUES ARE DETERMINED FØR CASES
C: WHERE THE LØAD CAUSING INCIPIENT CØLLAPSE IS TØ BE FØUND
13    IF(KINC.EQ.0)GØTØ 23
       PF=QU
       PFMAX=0
       PFMIN=PF/2.0
      GØTØ 20
16     PF=(PFMIN+PFMAX)/2.0
20    CALL FØRCE(2)
23    IF(KRF.EQ.0)GØTØ 24
      CALL FILL(PINT,2)
C
C: INITIALIZE VALUES FØR BETA METHØD (BETA = 1/6) AND CØMPUTE VALU
C: FØR FIRST TIME INTERVAL ASSUMING WALL INITIALLY AT REST
24     I=1
       TIME=0
      T(1)=0$ V(1)=0$ Y(1)=0
       DELTA=0.001
      IF(KWALL.EQ.0)GØTØ 29
27    IF(TIME.GE.(DELAY-0.00001))GØTØ 28
      TIME=TIME+DELTA
      CALL FILL(PINT,3)
      GØTØ 27
28    PIN(1)=PINT
      TPNET=AREA*PINT
      T(1)=TIME
      GØTØ 30
29    CALL FØRCE(3)
      PEX(I)=PEXT
      TPNET=AREA*PEXT
       PN(1)=PEXT
30     CALL RESIST(2)
       A(1)=TPNET/(ZMASS*ZKLM)
       VV(1)=VV1*TPNET
       VH(1)=VH1*TPNET
C
C: PRØCEDURE FØR ALL SUBSEQUENT TIME INTERVALS
1      I=I+1
      IF(I.LT.101)GØTØ 11
      PRINT 98,TIME
98    FØRMAT(/,*I=101:  TIME =*,F6.3,*:  WALL ASSUMED TØ NØT FAIL*)
      GØTØ 6
```

PROGRAM UNREINF (CONTINUED)

```
 11   TIME=TIME+DELTA
       T(I)=TIME
       A(I)=A(I-1)
       CALL FORCE(3)
       PEX(I)=PEXT
      IF(KWALL.EQ.1)GOTO 10
      IF(KRF.EQ.0)GOTO 3
      CALL FILL(PINT,3)
       PIN(I)=PINT
      TPNET=AREA*(PEXT-PINT)
       GOTO 2
 3     TPNET=AREA*PEXT
      GOTO 2
 10   CALL FILL(PINT,3)
      PIN(I)=PINT
      TPNET=AREA*PINT
 2    PN(I)=TPNET/AREA
      DO 8 JJ=1,10
       Y(I)=Y(I-1)+DELTA*V(I-1)+DELTA*DELTA*(A(I-1)/3.+A(I)/6.)
       CALL RESIST(2)
       QT=Q*AREA
 4     ANEW=(TPNET-QT)/(ZMASS*ZKL4)
       ADELTA=ANEW-A(I)
       A(I)=ANEW
IF(ANEW.EQ.0)PRINT,*1985*,TIME,TPNET,QT,ZMASS,ZKL4,Y(I),A(I-1)
      IF(ABS(ADELTA/(ANEW+1.0E-10)).LT.0.01)GOTO 9
 8     CONTINUE
       A(I)=ANEW-ADELTA/2.0
       WRITE(1,80)TIME,PF,A(I),Y(I)
 9     CONTINUE
       Y(I)=Y(I-1)+DELTA*V(I-1)+DELTA*DELTA*(A(I-1)/3.+A(I)/6.)
       V(I)=V(I-1)+DELTA*(A(I)+A(I-1))/2.0
       VV(I)=VV1*TPNET+VV2*QT
       VH(I)=VH1*TPNET+VH2*QT
      IF(VV(I).GT.VFAIL)GOTO 7
C
C: CHECK FOR MAXIMUM DEFLECTION OR FAILURE OF WALL
C:   IF MAXIMUM DEFLECTION REACHED, WALL DID NOT FAIL
      IF(Y(I).LE.Y(I-1).AND.PN(I).LE.PN(I-1))GOTO 6
      IF(Y(I).LT.0)GOTO 6
      IF(TIME-DELAY.GE.0.010)DELTA=0.002
      IF(Y(I).LT.Y J)GOTO 1
      IF(TIME-DELAY.GE.0.020)DELTA=0.005
      IF(TIME-DELAY.GE.0.100)DELTA=0.010
      IF(TIME-DELAY.GE.0.500)DELTA=0.050
C   IF FAILURE DEFLECTION REACHED, WALL FAILED
      IF(Y(I).GE.YFAIL)GOTO 7
       GOTO 1
C
C: INTERVAL HALVING PROCEDURE TO DETERMINE LOAD CAUSING INCIPIENT
C: COLLAPSE FOR CASES WHERE DESIRED
C:   WALL DID NOT FAIL - SET PFMIN TO PF
 6    CONTINUE
      IF(KRAND.EQ.1)GOTO 36
      IF(KINC.EQ.0)GOTO 18
 36   PFMIN=PF
       IF(PFMAX.GT.0)GOTO 17
       PF=2.0*PF
       GOTO 20
C:   WALL FAILED - SET PFMAX TO PF
 7    CONTINUE
      TIMEC=TIME
      IF(KRAND.EQ.1)GOTO 37
      IF(KINC.EQ.0)GOTO 18
 37   PFMAX=PF
C:   CHECK TO SEE IF LOAD RANGE IS WITHIN DESIRED ACCURACY
 17    IF((PFMAX-PFMIN)/PFMIN.GT.0.01)GOTO 16
      IF(KRAND.NE.1)GOTO 18
      CALL RANDOM(3)
      GOTO 34
C
C: OUTPUT DATA INCLUDES THE MAXIMUM DEFLECTION AND TIME OF
C: OCCURANCE FOR A NON-FAILING WALL OR THE TIME AND VELOCITY
C: AT COLLAPSE FOR A FAILING WALL.  OPTIONAL OUTPUT IS THE
```

PROGRAM UNREINF (CONTINUED)

```
C: ENTIRE BEHAVIØR TIME-HISTØRY ØF THE WALL.
C
C: ØUTPUT LØAD DATA
 18     CALL FØRCE(4)
C
C: ØUTPUT FINAL RESULTS
        IF(Y(I).LT.YFAIL)WRITE(1,70)Y(I),T(I)
        IF(Y(I).GE.YFAIL)WRITE(1,71)T(I),V(I)
C
C: CHECK TØ SEE IF ENTIRE TIME-HISTØRY ØF WALL IS DESIRED
        WRITE(1,72)
 READ,M
        IF(M.EQ.0)GØTØ 25
       IF(KWALL.EQ.1)GØTØ 32
       IF(KRF.EQ.0)GØTØ 26
        WRITE(1,75)(T(J),PEX(J),PIN(J),PN(J),Y(J),VV(J),VH(J),J=1,I)
        GØTØ 25
 26     WRITE(1,76)(T(J),PEX(J),A(J),V(J),Y(J),VV(J),VH(J),J=1,I)
       GØTØ 25
 32    WRITE(1,76)(T(J),PIN(J),A(J),V(J),Y(J),VV(J),VH(J),J=1,I)
 25     WRITE(1,77)
        GØTØ 5
C
 67 FØRMAT(/*INPUT TITLE*,+)
 68 FØRMAT(A59)
 70 FØRMAT(/*WALL DID NØT FAIL - MAX. DEFLECTIØN ØF*F6.2
+     * IN. REACHED AT*F7.3,* SEC*)
 71 FØRMAT(/*WALL FAILED AT*,F7.3,* SEC (FINAL VELØCITY =*
+    F7.2* IN./SEC)*)
 72 FØRMAT(/*IS TIME HISTØRY ØF WALL DESIRED (YES=1, NØ=0)*,+)
 75 FØRMAT(/,15X,*PRESSURE ØN WALL*/*  TIME   EXTERIØR  *
+ *INTERIØR    NET     DISPLACEMENT    VV       VH*/
+    (F6.3,3F10.3,F12.4,F11.0,F8.0))
 76 FØRMAT(/*  TIME  PRESSURE  ACCELERATIØN  VELØCITY  *
+    *DISPLACEMENT     VV       VH*/
+    (F6.3,F9.3,F12.1,F12.2,F12.4,F11.0,F8.0))
 77     FØRMAT(///,7(*-----------*))
 90 FØRMAT(/*ACCELERATIØN NØT CØNVERGING AT TIME =*,F6.3,
+             * SEC (PF =*,F7.3,* PSI)*/*     A(I) SET EQUAL TØ*,
+             F8.1,* (AVG ØF LAST 2 ITERATIØNS)*/*      Y(I) =*,
+             F8.4,* IN.*)
 95 FØRMAT(/*INPUT KWALL(0=EXT,1=INT),KINC,LØTYPE,KRF,KRAND*,
+    *(1=RANDØM)*)
 96 FØRMAT(/*INPUT DELAY TIME (MSEC) TØ INITIAL LØADING ØF*,
+    * INTERIØR WALL*,+)
C
 999    STØP
       END
 SUBRØUTINE FØRCE(IENTRY)
C  THIS SUBRØUTINE INPUTS THE LØAD PARAMETERS AND DETERMINES
C  THE LØAD AT A GIVEN TIME FØR THE FØLLØWING LØAD TYPES:
C      1. IDEALIZED BLAST LØAD (FRØNT ØR SIDE FACE)
C
 CØMMØN Y(100),YU,YFAIL,Q,QU,AREA,ZMASS,ZKLM,VH1,VH2,VV1,VV2
 CØMMØN KWALL,KINC,KRF,KRAND,I,ICASE,FU,VFAIL,FR,FPM,EM,FDY
 CØMMØN FDC,D(4),LDTYPE,P,PR,PSØ,PDØ,PC,TC,TO,PØ,TIME,LL,S
C
 GØTØ(100,200,300,4),IENTRY
C
C  INPUT LØAD PARAMETERS
 100 IF(KRAND.EQ.0)GØTØ 102
 W=1000 $ PØ=14.7 $ CØ=1120.0 $ LØC=1
 RETURN
 102 PRINT 600
 READ,W,PØ,CØ,LØC,S
 IF(LØC.EQ.1)GØTØ 105
 PRINT 605
 READ,ZLEV,CD
 105 IF(KINC.EQ.1)RETURN
 PRINT 630
 READ,PSØ
 PR=2.0*PSØ*(7.0*PØ+4.0*PSØ)/(7.0*PØ+PSØ)
 GØTØ 215
C
```

PROGRAM UNREINF (CONTINUED)

```
11010C  CALCULATE L3AD PR3PERTIES F3R GIVEN PEAK PRESSURE
11030 200 G3T3(205,210),L3C
11040 205 PS0=(PR-14.0*P3+SQRT(196.0*P3*P3+196.0*P3*PR+PR*PR))/16.0
11050 G3T3 215
11060 210 PS3=PR
11070 215 PD3=2.5*PS0*PS0/(7.0*P3+PS3)
11080 U=C3*SQRT(1.0+(6.0*PS3)/(7.0*P3))
11090 TO=W**0.3333/(2.2399+0.1886*PS3))
11100 G3T3(220,'    .3C
11110 220 TC=3.0*_
11120 PC=PS3*(1-TC/TU.*EXP(-TC/TO)+PD3*(1-TC/TO)**2*EXP(-2*TC/TO)
11130 CD=1.0
11140 RETURN
11150 225 TA=ZLEN/U
11160 TA2=TA/2.0
11170 TA2TO=TA2/TO
11180 PA=PS3*(1-TA2TO)*EXP(-TA2TO)+CD*PD3*(1-TA2TO)**2*EXP(-2*TA2TO)
11190 RETURN
12000C
12010C  CALCULATE L3AD
12030 300 G3T3(305,310),L3C
12040 305 TTO=TIME/TO
12050 IF(TIME.GT.TC)G3T3 320
12060 P=PC+(TC-TIME)*(PR-PC)/TC
12070 RETURN
12080 310 TTO=(TIME-TA2)/TO
12090 IF(TIME.GT.TA)G3T3 320
12100 P=PA*TIME/TA
12110 RETURN
12120 320 IF(TTO.GE.1.0)G3T3 330
12130 P=PS0*(1-TTO)*EXP(-TTO)+CD*PD3*(1-TTO)**2*EXP(-2*TTO)
12150 RETURN
12160 330 P=0
12170 RETURN
13000C
13010C  PRINT L3AD DATA
13020 4 IF(KINC.EQ.0)G3T3 400
13030 PRINT 640,LDTYPE
13040 G3T3 410
13050 400 PRINT 645,LDTYPE
13060 410 C3NTINUE
13070 415 G3T3(420,425),L3C
13080 420 PRINT 650
13090 G3T3 430
13100 425 PRINT 655
13110 430 PRINT 660,W,P3,C3
13120 IF(KRAND.NE.0)RETURN
13130 G3T3(435,440),L3C
13140 435 PRINT 665,S,TC,PR
13150 G3T3 445
13160 440 PRINT 670,ZLEN,TA,PA
13170 445 PRINT 675,U,TO,CD,PS3,PD3
13180 RETURN
14000C
14010 600 F3RMAT(/*INPUT W,P3,C3,L3C,S*,+)
14020 605 F3RMAT(/*INPUT L,CD*,+)
14060 630 F3RMAT(/*INPUT PS0*,+)
14070 640 F3RMAT(/*L3AD CAUSING INCIPIENT FAILURE IS AS F3LL3WS:*,
14071+     /,5X,*L3AD TYPE NUMBER*,I2)
14080 645 F3RMAT(/*PR3PERTIES 3F L3AD ACTING 3N WALL ARE AS F3LL3WS:*,
14081+     /,5X,*L3AD TYPE NUMBER*,I2)
14090 650 F3RMAT(8X,*(FR3NT FACE)*)
14100 655 F3RMAT(8X,*(SIDE FACE)*)
14110 660 F3RMAT(10X,*W =*,F8.1,* KT    P3 =*,F6.2,* PSI      C3 =*,
14111+     F7.1,* FPS*)
14120 665 F3RMAT(10X,*S =*,F6.1,* FT      TC =*,F6.3,* SEC      PR =*,
14121+     F7.3,* PSI*)
14130 670 F3RMAT(10X,*L =*,F6.1,* FT      TA =*,F6.3,* SEC      PA =*,
14131+     F7.3,* PSI*)
14140 675 F3RMAT(10X,*U =*,F7.1,* FPS    TO =*,F6.3,* SEC      CD =*,
14141+     F5.1,/,8X,*PS3 =*,F7.3,* PSI   PD3 =*,F7.3,* PSI*)
15000 END
```

PROGRAM UNREINF (CONTINUED)

```
SUBRØUTINE FILL(P3,IENTRY)
C: CØMPUTES AVERAGE AIR PRESSURE IN RØØM DUE TØ BLAST WAVE
C: INCIDENT HEAD-ØN UPØN FRØNT WALL.
C
CØMMØN Y(100),YU,YFAIL,Q,QU,AREA,ZMASS,ZKLM,VH1,VH2,VV1,VV2
CØMMØN KWALL,KINC,KRF,KRAND,II,ICASE,FU,VFAIL,FR,FPM,EM,FDY
CØMMØN FOC,D(4),LDTYPE,PEXT,PR,PSØ,PDØ,PC,TC,TO,PØ,TIME,L,S
DIMENSIØN AA(8,2),NN(8)
LØGICAL L1,L2,L3
GØTØ(10,13,11),IENTRY
10 PRINT 700
RHØØ=0.076 $ L1=.FALSE.
READ,NWIN,V3
AT=0$ AFRØNT=0$ ASIDE=0
DØ 18 I=1,NWIN
PRINT 710,I
READ,AA(I,1),NN(I),AA(I,2)
AA(I,2)=AA(I,2)/1000.0
AT=AT+AA(I,1)
M=NN(I)$ GØTØ(12,14,14),M
12 AFRØNT=AFRØNT+AA(I,1)
GØTØ 18
14 ASIDE=ASIDE+AA(I,1)
18 CØNTINUE
AFRØNT=AFRØNT/AT$ ASIDE=ASIDE/AT
700 FØRMAT(/*INPUT NWIN AND RØØM VØLUME (CF)*,*)
710 FØRMAT(/*INPUT AREA (SQ FT),LØCATIØN CØDE & DELAY(MSEC)*
+ * FØR WINDØW*,I2,*)
G=1.4 $ G2=1./G $ G3=1.-G2 $ G4=2./G3 $ G5=G+1.
G6=2.*G/G5 $ G7=(G-1.)/G5
PP2=.1912
C=SQRT(G*PØ*32.*144./RHØØ)
TAU=2.*(V3**(1./3.))/C
NSTEP=4
DT=TAU/NSTEP
RETURN
C
13 P3Ø=PØ
TT=0.$ TØ=0.
RHØ3Ø=RHØØ
L2=.FALSE. $ L3=.FALSE.
RETURN
C
11 IF(L1)GØTØ 52
IF(L2.A.L3)GØTØ 9
52 DDT=(TIME-TØ)*0.5
ISTØP=2
53 IF(DDT.LT.DT)GØTØ 51
50 DDT=0.5*DDT
ISTØP=2*ISTØP
GØ TØ 53
51 CØNTINUE
DØ 99 I=1,ISTØP
TT=TØ+I*DDT
IF(TT.GT.TO)GØ TØ 99
DM=0. $ WW=0. $ NW=0
DØ 500 K=1,NWIN
M=NN(K) $ DLY=AA(K,2)+0.000001
IF(DLY.GE.TT)GØ TØ 500
GØTØ(15,16,16),M
15 CDF=1.0
IF(TT-TC)20,20,21
20  P11=(TC-TT)*(PR-PC)/TC+PC
P11=P11+PØ
GØ TØ 30
16 CDF=-0.4
21  R=TT/TO $ RR=1.-R
PD=PDØ*RR*RR*EXP(-2.*R)
PS=PSØ*RR*EXP(-R)
P11=PS+CDF*PD
P11=P11+PØ
30  RHØ1=RHØØ*((P11/PØ)**G2)
IF(P11-P3Ø)36,36,37
36  JSIGN=-1
```

PROGRAM UNREINF (CONTINUED)

```
L2=.TRUE.
303  P2=P11
RHØ2=((P2/P33)**G2)*RHØ33
X=P33/RHØ33
GØ TØ 38
37  JSIGN=+1
306 P2=PP2*P11
RHØ2=((P2/P11)**G2)*RHØ1
X=P11/RHØ1
38  U22=G4*(X-P2/RHØ2)*32.*144.
IF(U22)40,39,39
40  PRINT,*U22 NEGATIVE*,U22
STØP
39  U2=SQRT(U22)*JSIGN
DDM=U2*RHØ2*AA(K,1)*DDT
DM=DM+DDM
WW=WW+P11*DDM/(G3*RHØ1)
500 CØNTINUE
P3Ø=P3Ø+(G-1.)*WW/V3
RHØ3Ø=RHØ3Ø+DM/V3
99  CØNTINUE
TØ=TT
P3=P3Ø-P3
IF(TIME.GE.TC)L3=.TRUE.
RETURN
9 R=TIME/TO $ RR=1.0-R
PD=PDØ*RR*RR*EXP(-2.0*R)
PS=PSØ*RR*EXP(-R)
P3=PS+PD*(AFRØNT-0.4*ASIDE)
999 RETURN
END
SUBRØUTINE RESIST (IENTRY)
C
C:  THIS SUBRØUTINE DETERMINES THE RESISTANCE FUNCTIØN FØR AN
C:  UNREINFØRCED MASØNRY WALL WITH ØR WITHØUT ØPENINGS.  CASES
C:  1-4 ARE TWØ-WAY WALLS AND CASES 5-7 ARE ØNE-WAY WALLS
C
CØMMØN Y(100),YU,YFAIL,Q,QU,AREA,ZMASS,ZKLM,VH1,VH2,VV1,VV2
CØMMØN KWALL,KINC,KRF,KRAND,I,ICASE,FU,VFAIL,FR,FPM,EM,FDY
CØMMØN FDC,D(4),LDTYPE,PEXT,PF,PSØ,PDØ,PC,TC,TO,PØ,TIME,L,S
CØMMØN /RAND/ TIMEC,IWALL
REAL K1,K2,K3,KUD,N,IC,ICTØT,IG,KK1,KK2,KK3,MM,MPR,MPRSQ
REAL KS,KF,KEP,KEQ,NU,MU
C
GØTØ(5,500,262),IENTRY
C
C:  INPUT WALL PARAMETERS
5 WRITE(1,600)
READ,ZLV,ZLH,TW,PV,E,FR,ICASE,ZLVW,ZLHW,GAMMA
WRITE(1,670)
C
C:  DETERMINE ELASTIC DEFLECTIØN AND MØMENT CØEFFICIENTS FØR
C:  TWØ-WAY WALLS WITHØUT INPLANE FØRCES
IWALL=1
R=ZLH/ZLV
ALP=1.0/R$ ALP2=ALP*ALP
IF(ICASE.LE.4)GØTØ 11
R=0$ ALP=0$ ALP2=0
11 AWALL=ZLV*ZLH
AWIN=ZLVW*ZLHW
AREA=AWALL-AWIN
ZMASS=GAMMA*AREA*TW/(386.07*1728.0)
B=0.5*(ALP*SQRT(3.0+ALP2)-ALP2)
IG=TW**3/12.0
CALL CØEF (ICASE,R,ASS,BSS,AF,BF,IG,ZLV,ZLH,PV,NX,CF,E,1)
CALL TRANS (B,ZLV,ZLH,ICASE,0,ZKLM,ZKLMSE,ZKLMFE,ZKLMP,VH1S,
+   VH2S,VV1S,VV2S,VH1F,VH2F,VV1F,VV2F,VH1P,VH2P,VV1P,VV2P)
C
C:  DETERMINE MØDIFICATIØN FACTØR FØR WALL WITH WINDØWS
C
290 ØMULT=1.0
IF(AWIN.NE.0)CALL WINDØW (ØMULT,ZLV,ZLH,ZLVW,ZLHW,AWIN,AWALL,
+     R,ICASE)
WRITE(1,620)ICASE,ZLV,ZLH,ALP,TW,FR,E,PV,GAMMA,ZLVW,ZLHW,ØMULT
```

PROGRAM UNREINF (CONTINUED)

```
30410 RETURN
30420C
30430C:  DETERMINE MAXIMUM RESISTANCE DURING DECAYING PHASE
30440C
30450 262 MM=(FR+PV/TW)*TW*TW/6.0
30460 W=ZLV*TW*GAMMA/1728.0
30470 IF(ICASE.GT.4)GOTO 278
30480 QEZERO=12.0*TW*(2.0*PV+W)*(1.0+0.5*ALP2/B)/(ZLV*ZLV*(3-2*B))
30490 GOTO 279
30500 278 QEZERO=8.0*TW*(PV+0.25*W)/(ZLV*ZLV)
30510 279 CONTINUE
30520 YFAIL=TW
30530 KEQ=QEZERO/TW
30540C
30550C:  DETERMINE MAXIMUM RESISTANCE DURING INITIAL (FLEXURAL) PHASE
30560 QU=MM/(BSS*ZLV*ZLV)
30570 KS=E*IG/(ASS*ZLV**4)
30580 YU=QU/KS
30590 IF(ICASE.EQ.1.OR.ICASE.EQ.5)GOTO 280
30600C
30610C:  CASES 2,3,4
30620 Q1=MM/(BF*ZLV*ZLV)
30630 KF=E*IG/(AF*ZLV**4)
30640 Y1=Q1/KF
30650 KEP=(QU-Q1)/(YU-Y1)
30660 GOTO 280
30670C
30680C:  DETERMINE WHETHER BENDING OR EQUILIBRIUM RESISTANCE IS LARGER
30690C
30700 280 IF(QU.LE.QEZERO)GOTO 285
30710C
30720C:  QU>QEZERO
30730 Y2=YU
30740 Q2=QEZERO*(1.0-YU/TW)
30750 GOTO 295
30760C
30770C:  QEZERO>QU
30780 285 Y2=QEZERO/(KS+KEQ)
30790 Q2=KS*Y2
30800 295 CONTINUE
30810C
30820C:  MODIFY RESISTANCE VALUES BY APPROPRIATE FACTOR
30830 310 Q1=Q1*QMULT
30840 Q2=Q2*QMULT
30850 QU=QU*QMULT
30860 KS=KS*QMULT$ KF=KF*QMULT$ KEP=KEP*QMULT$ KEQ=KEQ*QMULT
30870C
30880C:  OUTPUT LOAD-DEFLECTION CURVE
30890 IF(KRAND.EQ.1)GOTO 325
30900 PRINT 650
30910 IF(ICASE.EQ.1.OR.ICASE.EQ.5)GOTO 320
30920 WRITE(1,660)Q1,Y1
30930 320 XXXXX=0.0
30940 WRITE(1,660)QU,YU,Q2,Y2,XXXXX,YFAIL
30950 325 RETURN
30960C
30970C:  DETERMINE THE RESISTANCE (PER UNIT AREA) OF THE WALL AS
30980C:  A FUNCTION OF Y(I)
30990C
31000 500 IF(Y(I).GT.Y2)GOTO 520
31005 IF(Y(I).GT.YU)GOTO 502
31010 GOTO(502,510,510,510,502,510,510),ICASE
31020C
31030C:  ELASTIC: PHASE -- CASE 1
31040 502 Q=Y(I)*KS
31050 505 ZKLM=ZKLMSE
31060 VH1=VH1S$ VH2=VH2S
31070 VV1=VV1S$ VV2=VV2S
31080 RETURN
31090C
31100 510 IF(Y(I).GT.Y1)GOTO 515
31110C
31120C:  ELASTIC PHASE -- CASES 2,3,4
31130 Q=Y(I)*KF
```

PROGRAM UNREINF (CONTINUED)

```
ZKLM=ZKLMFE
VH1=VH1FS VH2=VH2F
VV1=VV1FS VV2=VV2F
RETURN
C
C:  *ELASTO-PLASTIC* PHASE (CASES 2,3,4)
515 Q=Q1+KEP*(Y(I)-Y1)
GOTO 505
C
C:  SECONDARY (EQUILIBRIUM) PHASE
520 IF(Y(I).GT.TW)GOTO 525
Q=KEQ*(TW-Y(I))
ZKLM=ZKLMP
VH1=VH1PS VH2=VH2P
VV1=VV1PS VV2=VV2P
RETURN
C
C:  WALL COLLAPSED -- NO RESISTANCE (TO AVOID DIFFICULTIES
C:  FOR CERTAIN CASES SET RESISTANCE EQUAL TO VERY SMALL VALUE)
525 Q=1E-10
RETURN
C
C
600 FORMAT(/*INPUT LV,LH,TW,PV,E,FR,ICASE,LVW,LHW GAMMA*)
620 FORMAT(/*WALL PROPERTIES -- SUPPORT TYPE NO.*,I2/
+ *  LV =*,F6.1,* IN.      LH =*,F6.1,* IN.   LV/LH =*,
+ F7.2/*  TW =*,F6.1,* IN.      FR =*,F7.1,* PSI*,5X,
+ * E =*,F10.1,* PSI*/*  PV =*,F6.1,* LB/IN.*,5X,
+ *GAMMA =*,F6.1,* PCF*,/,* LVW =*,F6.1,* IN.    LHW =*,
+ F6.1,* IN.   QMULT =*,F6.3)
650 FORMAT(/*LOAD-DEFLECTION CURVE*,/,3X,*Q (PSI)*,4X,*Y (IN.)*)
660 FORMAT(F9.2,F12.4)
670 FORMAT(1H )
C
END
SUBROUTINE COEF(ICASE,R,ASS,BSS,AF,BF,I,ZLV,ZLH,PV,NX,CF,
+     E,IENTRY)
C:  THIS SUBROUTINE DETERMINES MOMENT AND DEFLECTION COEFFICIENTS
C:  FOR ONE-WAY (CASES 5-7) AND TWO-WAY (CASES 1-4) WALLS
C
      REAL I,MPR,MPRSQ,NU
      IF(IENTRY.EQ.2)GOTO 200
      NX=1
       IF(ICASE.GT.4)GOTO 50
C
       R2=R*R
       R3=R*R2
       R4=R2*R2
       ASS=-.007030+.013990*R-.003456*R2+.000286*R3
       BSS=-.058332+.139314*R-.035609*R2+.003016*R3
8      GOTO(41,20,30,40),ICASE
C
C:  CASE 2. FIXED ON FOUR SIDES
20     NX=3
       AF=-.003430+.007327*R-.003365*R2+.0006646*R3-.00004766*R4
       BF=-.101150+.260875*R-.138992*R2+.034677*R3-.004016*R4
+   +.000170*R**5
      CF=-.1674+.3554*R-.1714*R2+.0286*R3
       GOTO 41
C
C:  CASE 3. FIXED ON SHORT SIDES, SIMPLY SUPPORTED ON LONG SIDES
30     NX=4
       AF=.004513-.017525*R+.023095*R2-.010325*R3+.002187*R4
+  -.000220B*R**5 + .000008409*R**6
      BF=-.122149+.313445*R-.153979*R2+.036132*R3-.004015*R4
+  +.0001646*R**5
      CF=2.1958-7.7564*R+10.8376*R2-7.2495*R3+2.344*R4
+        -.2954*R**5
       GOTO 41
C
C:  CASE 4. SIMPLY SUPPORTED ON SHORT SIDES, FIXED ON LONG SIDES
40     NX=3
       AF=-.002765+.008652*R-.005695*R2+.001529*R3-.0002859*R4
+  +.00001739*R**5
```

PROGRAM UNREINF (CONTINUED)

```
      BF=-.060320+.256515*R-.175648*R2+.057928*R3-.009227*R4
+     +.000569*R**5
 CF=5.8987*R-1.6669-7.9398*R2+5.3142*R3-1.7623*R4+.2313*R**5
C
 41   IF(R.GT.2.0)CF=1.0/12.0
      IF(PV.EQ.0)RETURN
      ARATIO=AF/ASS$  BRATIO=BF/BSS
      BFO=BF$ CFO=CF
      GOTO 220
C
 50   IF(PV.NE.0)GOTO 300
C:  CASE 5. ONE-WAY SIMPLY SUPPORTED WALL
      ASS=5.0/384.0
       BSS=0.125
       GOTO(270:270,270,270,270,60,70),ICASE
C
C:  CASE 6. ONE-WAY FIXED END WALL
 60    AF=1.0/384.0
       BF=1.0/12.0
      CF=1.0/12.0
      NX=3
      RETURN
C
C:  CASE 7. ONE-WAY PROPPED CANTILEVER WALL
 70    AF=1.0/185.0
       BF=0.125
      CF=0.125
      NX=3
      RETURN
C
 200  IF(ICASE.GT.4)GOTO 300
C:  DETERMINE ELASTIC DEFLECTION AND MOMENT COEFFICIENT FOR
C:  TWO-WAY WALL WITH INPLANE FORCES
 220  PI=3.14159165
       NU=0.3
      PE=4.0*PI*PI*E*I/(ZLV*ZLV*(1.0-NU*NU))
       BV=0
 230   AV=0
       PPE=PV/PE
       TERM6=4.0*PI*PI*R*SQRT(PPE)
C
C:  SERIES SOLUTION USED TO DETERMINE COEFFICIENTS
       DO 250 M=1,7,2
       MPR=M*PI*R
       MPRSQ=MPR**2
       GMSQ=MPRSQ+2.0*MPR*PI*SQRT(PPE)
       EMSQ=MPRSQ-2.0*MPR*PI*SQRT(PPE)
       TERM5=M*MPRSQ*(MPRSQ-4.0*PI*PI*PPE)
       COSHGM2=0.5*(EXP(0.5*SQRT(GMSQ))+EXP(-0.5*SQRT(GMSQ)))
       IF(EMSQ.LT.0)GOTO 240
       COSHEM2=0.5*(EXP(0.5*SQRT(EMSQ))+EXP(-0.5*SQRT(EMSQ)))
       GOTO 245
 240   COSHEM2=COS(0.5*SQRT(-EMSQ))
 245   AV=AV+(1.0+(EMSQ/COSHGM2-GMSQ/COSHEM2)/(M*TERM6))
+  *(-1)**((M-1)/2)/TERM5
       BV=BV+(MPRSQ+(GMSQ*(NU*EMSQ-MPRSQ)/COSHEM2-EMSQ*(NU*GMSQ
+        -MPRSQ)/COSHGM2)/(M*TERM6))*(-1)**((M-1)/2)/TERM5
 250   CONTINUE
C
C:  CASE 1
      AVSS=AV*(1.0-NU*NU)*R4*4.0/PI
       BVSS=BV*R2*4.0/PI
       IF(ICASE.EQ.1)GOTO 260
C
C:  CASES 2, 3, AND 4
      AVF=AVSS*ARATIO
      BVF=BVSS*BRATIO
      CF=CFO*BVF/BFO
 259  AF=AVF
       BF=BVF
 260  ASS=AVSS
       BSS=BVSS
 270  RETURN
```

```
C
C:  ONE-WAY WALLS
 300  EIPV=E*I/PV
      U=ZLV/SQRT(EIPV)
      U2=0.5*U
      TERM1=1.0/COS(U2)-1.0
C
C:  CASE 5. ONE-WAY SIMPLY SUPPORTED WALL
      BSS=TERM1/U**2
      ASS=(BSS-0.125)/U**2
      GOTO(270,270,270,270,270,310,320),ICASE
C
C:  CASE 6. ONE-WAY FIXED END WALL
 310  NX=3
      BF=(1.0-U2/TAN(U2))/U**2
      AF=-BF+BSS+ASS
      RETURN
C
C:  CASE 7. ONE-WAY PROPPED CANTILEVER WALL
 320 NX=3
      BF=TAN(U)*(TAN(U2)-U2)/(U*(TAN(U)-U))
      AF=(BF*(0.5+SIN(U2)/TAN(U)-COS(U2))-(SIN(U2)/TAN(U)
     +   -COS(U2)-SIN(U2)/SIN(U)+0.125*U*U+1.0)/U**2)/U**2
      RETURN
 999 END
      SUBROUTINE TRANS (B,ZLV,ZLH,ICASE,KRAK,ZKLM,ZKLMSE,ZKLMFE,
     + ZKLMP,VL1S,VL2S,VS1S,VS2S,VL1F,VL2F,VS1F,VS2F,VL1P,VL2P,
     + VS1P,VS2P)
C
C: THIS SUBROUTINE DETERMINES LOAD AND MASS TRANSFORMATION FACTORS
C: AND DYNAMIC REACTION COEFFICIENTS FOR TWO-WAY WALLS.
C
C: DETERMINE LOAD AND MASS TRANSFORMATION FACTORS
      B2=B*B
      B3=B*B2
      B4=B2*B2
      B5=B2*B3
      B6=B3*B3
C
C: CASES 1 & 5 -- ELASTIC RANGE
 330  ZKMSE1=20.48*B3*(1./12.-B2/7.5+B3/21+B4/14-B5/18+B6/90)
      ZKMSE2=0.5038-0.7066*B
      ZKLSE1=6.4*B2*(1./6.-B2/10.+B3/30.)
      ZKLSE2=0.64-0.8134*B
      BARS1=B*(1./12.-B2/15.+B3/42.)/(1./6.-B2/10.+B3/30.)
      BARS2=(0.127083-0.184524*B)/(0.4-0.508333*B)
      ZKMSE=ZKMSE1+ZKMSE2
      ZKLSE=ZKLSE1+ZKLSE2
      IF(KRAK.EQ.1)GOTO 335
C: CRACK PATTERN A
      CVS=0.5*B
      CVL=0.5*(1.0-B)
      XP=ZLH*B/3.0
      XBARS=BARS1*ZLH
      ZP=ZLV*(1.0-4.0*B/3.0)/(4.0*(1.0-B))
      ZBARS=BARS2*ZLV
      XBARP=0.5*B*ZLH
      ZBARP=ZLV*(1./24.-B/16.)/(1./8.-B/6.)
      GOTO 338
C: CRACK PATTERN B
 335  CVS=0.5*(1.0-B)
      CVL=0.5*B
      XP=ZLH*(1.0-4.0*B/3.0)/(4.0*(1.0-B))
      XBARS=BARS2*ZLH
      ZP=ZLV*B/3.0
      ZBARS=BARS1*ZLV
      XBARP=ZLH*(1./24.-B/16.)/(1./8.-B/6.)
      ZBARP=0.5*B*ZLV
 338  ZKLMSE=ZKMSE/ZKLSE
      ZKLM=ZKLMSE
      GOTO(390,340,350,360,390,340,470),ICASE
C
C: CASES 2, 3, & 4 -- ELASTIC RANGE
  350 IF(KRAK.EQ.1)GOTO 365
```

PROGRAM UNREINF (CONTINUED)

```
      GOTO 340
360   IF(KRAK.EQ.0)GOTO 365
C: CASES 2A, 2B, 3A, 4B, & 6
340   ZKMFE1=512.0*B5*(1.0/30.-B/10.+3.*B2/28.-B3/18.+B4/90.)
      ZKLFE1=32.0*B3*(1./12.-B/10.+B2/30.)
      BARF1=B*(.05-B/15.+B2/42.)/(1./12.-B/10.+B2/30.)
      GOTO(370,365,370,370,370,365),ICASE
C: CASES 2A, 2B, 3B, 4A, & 6
365   ZKMFE2=0.4065-0.6144*B
      ZKLFE2=0.5344-0.7328*B
      BARF2=(.091667-.138095*B)/(.266667-.366667*B)
      GOTO(375,368,375,375,375,368),ICASE
C: CASES 2A & 2B
368   ZKMFE=ZKMFE1+ZKMFE2
      ZKLFE=ZKLFE1+ZKLFE2
      GOTO 380
C:  CASES 3A & 4B
370   ZKMFE=ZKMFE1+ZKMSE2
      ZKLFE=ZKLFE1+ZKLSE2
      GOTO 380
C: CASES 3B, 4A, & 6
375   ZKMFE=ZKMSE1+ZKMFE2
      ZKLFE=ZKLSE1+ZKLFE2
380   ZKLMFE=ZKMFE/ZKLFE
      ZKLM=ZKLMFE
      GOTO 390
C: CASE 7
470   ZKLMFE=0.78
C
C: ALL CASES -- PLASTIC RANGE
390   ZKMP=(1.0-B)/3.0
      ZKLP=0.5-B/3.0
      ZKLMP=ZKMP/ZKLP
C
C
C: DETERMINE DYNAMIC REACTION COEFFICIENTS FOR SHORT (VS) AND
C: LONG (VL) EDGES
C
      IF(ICASE.LT.5)GOTO 395
      XBARS=1E-10$ BARF1=1E-10$ XBARP=1E-10
395   CONTINUE
      GOTO(450,400,400,420,450,400,445),ICASE
400   IF(KRAK.EQ.1)GOTO 410
      XBARF=BARF1*ZLH
      IF(ICASE.EQ.3)GOTO 430
405   ZBARF=BARF2*ZLV
      GOTO 440
410   XBARF=BARF2*ZLH
      IF(ICASE.EQ.3)GOTO 435
415   ZBARF=BARF1*ZLV
      GOTO 440
420   IF(KRAK.EQ.1)GOTO 425
      XBARF=BARS1*ZLH
      GOTO 405
425   XBARF=BARS2*ZLH
      GOTO 415
430   ZBARF=BARS2*ZLV
      GOTO 440
435   ZBARF=BARS1*ZLV
440   CONTINUE
C
C: CASES 2, 3, 4, & 6 -- ELASTIC RANGE
      VS1F=CVS*(1.0-XP/XBARF)
      VS2F=CVS*(XP/XBARF)
      VL1F=CVL*(1.0-ZP/ZBARF)
      VL2F=CVL*(ZP/ZBARF)
      VS1=VS1F
      VL1=VL1F
      GOTO 450
C
C: CASE 7 -- ELASTIC RANGE
445   VS1F=0
      VS1=0
      VL1F=0.459
```

PROGRAM UNREINF (CONTINUED)

```
      VL1=VL1F
      VL2F=0.165
C
C: CASE 1 & 5 -- ELASTIC RANGE
  450 VS1S=CVS*(1.0-XP/XBARS)
      VS2S=CVS*(XP/XBARS)
      VL1S=CVL*(1.0-ZP/ZBARS)
      VL2S=CVL*(ZP/ZBARS)
      GOTO(455,460,460,460,455,460,460),ICASE
  455 VS1=VS1S
      VL1=VL1S
C
C: ALL CASES -- PLASTIC RANGE
  460 VS1P=CVS*(1.0-XP/XBARP)
      VS2P=CVS*(XP/XBARP)
      VL1P=CVL*(1.0-ZP/ZBARP)
      VL2P=CVL*(ZP/ZBARP)
      RETURN
      END
 SUBROUTINE WINDOW(OMULT,ZLV,ZLH,ZLVW,ZLHW,AWIN,AWALL,R,ICASE)
C
C: THIS SUBROUTINE DETERMINES THE STRUCTURAL
C: MODIFICATION FACTOR FOR WALLS WITH WINDOWS
 IF(ICASE.GT.4.AND.ICASE.NE.10)GOTO 320
 RWWS=ZLVW/ZLV
 RWWL=ZLHW/ZLH
 RAREA=AWIN/AWALL
 IF(R.LE.1.5)GOTO 300
 IF(RWWS.GT.0.7)GOTO 300
 IF(RWWL.LT.0.5)GOTO 300
 IF(RWWS.EQ.RWWL)GOTO 300
C
C:  CASE WHERE LV/LH >= 1.5, LVW/LV <= 0.7, AND LHW/LH >= 0.5
C:  (BUT LVW/LV NOT EQUAL TO LHW/LH)
 OMULT=-5.85461-12.6644*RAREA+4.39662*RWWS+0.84943*RWWL
+      -0.223*R-1.07269*(ZLVW/ZLHW)**0.9+6.59942*EXP(RAREA)
 GOTO 315
C
C:  CASE WHERE ONE OR MORE OF ABOVE CONDITIONS IS NOT MET
 300 OMULT=0.62022-2.23415*RAREA**(RWWL**4)-0.79461*RWWL**2
+       -2.27663*RWWL+0.62522*RWWL/RAREA**0.3
+       +2.63043*EXP(RAREA)-0.07268*RWWS
 315 CONTINUE
 RETURN
C
C ONE-WAY ACTION WALLS
 320 OMULT=(AWALL-ZLV*ZLHW)/(AWALL-AWIN)
 RETURN
 END
       SUBROUTINE RANDOM (IENTRY)
C THIS SUBROUTINE INPUTS MEAN AND STANDARD DEVIATIONS FOR RANDOM
C VARIABLES, GENERATES RANDOM VALUES, AND CONTROLS REQUIRED
C NUMBER OF CASES TO BE RUN, AND OUTPUTS FINAL RESULTS AND SUMMARY
C
       COMMON Y(100),YU,YFAIL,D,DU,AREA,ZMASS,ZKLM,VH1,VH2,VV1,VV2
       COMMON XWALL,XINC,XRF,XRAND,I,ICASE,FU,VFAIL,FR,FPM,EM,FDY
       COMMON FDC,D(4),LDTYPE,PEXT,PF,PSO,PUO,PC,TC,TO,PB,TIME,L,S
       COMMON /RAND/ TIMEC,IWALL
       DIMENSION CHI25(7),CHI975(7),TDIST(7)
C
C VALUES FOR 97.5% (F=19,24,29,34,39,44,49)
       DATA CHI25/.4683,.5167,.5533,.5825,.6065,.6267,.6440/
       DATA CHI975/1.7295,1.6402,1.5766,1.5284,1.4903,1.4591,1.4331/
       DATA TDIST/2.093,2.064,2.045,2.032,2.022,2.016,2.010/
C
       GOTO(5,50,70),IENTRY
     5 XDUMMY=XNORM1(-1.0,0.0,1.0)
C INITIALIZE RANDOM NUMBER GENERATOR
       PRINT,/,*INPUT NRAND*,
       READ,NRAND
       DO 47 I=1,NRAND
       XDUMMY=XNORM1(0.0,0.0,1.0)
    47 CONTINUE
       INDEX=0$  SPSO=0$  SSPSO=0
```

PROGRAM UNREINF (CONTINUED)

```
      ICHECK=20
C
C  INPUT MEAN AND STANDARD DEVIATION FOR RANDOM VARIABLES
      PRINT 97
      READ,SMEAN,SSD
      GOTO(10,20),IWALL
C  UNREINFORCED WALLS WITHOUT ARCHING
 10   PRINT 84
      READ,FRMEAN,FRSD
      PRINT 94
      RETURN
C  UNREINFORCED WALLS WITH ARCHING
 20   PRINT 85
      READ,FPMMEAN,FPMSD
      PRINT 95
      RETURN
C
C  GENERATE RANDOM VALUES
 50   GOTO(52,54),IWALL
 52   FR=XNORM1(0.0,FRMEAN,FRSD)
      IF(FR.LE.0)GOTO 52
      GOTO 58
 54   FPM=XNORM1(0.0,FPMMEAN,FPMSD)
      IF(FPM.LE.0)GOTO 54
 55   ALPHA=XNORM1(0.0,1.0,0.3)
      IF(ALPHA.LT.0.4.OR.ALPHA.GT.1.6)GOTO 55
      EM=1000.0*ALPHA*FPM
 58   IF(SMEAN.EQ.0)GOTO 65
 60   S=XNORM1(0.0,SMEAN,SSD)
      IF(S.LE.0)GOTO 60
 65   INDEX=INDEX+1
      RETURN
C SUM VALUES OF PSO AND PSO**2 FOR USE IN STATISTICAL ANALYSIS
 70   SPSO=SPSO+PSO
      SSPSO=SSPSO+PSO*PSO
C
C OUTPUT FINAL RESULTS
      GOTO(72,74),IWALL
 72   PRINT 90,FR,S,PSO,TIMEC
      GOTO 80
 74   PRINT 91,FPM,EM,S,PSO,TIMEC
      GOTO 80
 80   IF(INDEX.LT.ICHECK)RETURN
C
C DETERMINE MEAN, STANDARD DEVIATION, AND STANDARD ERROR FOR PSO
      ZNO=INDEX
      ZMEAN=SPSO/ZNO
      SD=SQRT((SSPSO-ZNO*ZMEAN*ZMEAN)/ZNO)
      STDERR=SD/(SQRT(ZNO-1))
C CHECK IF MAXIMUM OF 50 PSO SAMPLES OBTAINED
      IF(INDEX.EQ.50)GOTO 62
C CHECK IF 95% CONFIDENCE INTERVAL FOR MEAN PSO VALUE IS
      IF(STDERR*TDIST((INDEX-15)/5)/ZMEAN.GT.0.10)GOTO 61
C
C CONFIDENCE INTERVAL IS WITHIN 10% -- DETERMINE UPPER LIMIT OF
C 95% CONFIDENCE INTERVAL FOR STANDARD DEVIATION
C PROBABILITY VALUE AND ITS 95% CONFIDENCE INTERVAL UPPER LIMIT
  62 SDU=SD/(SQRT(CHI25((INDEX-15)/5)))
C CHECK IF MAXIMUM OF 50 PSO SAMPLES OBTAINED
      IF(INDEX.EQ.50)GOTO 53
C CHECK IF UPPER VALUE OF 95% CONFIDENCE INTERVAL FOR STANDARD
C DEVIATION IS WITHIN 0.10*MEAN OF THE STANDARD DEVIATION
      IF(((SDU-SD)/ZMEAN).GT.0.10)GOTO 61
C
C 95% CONFIDENCE INTERVAL IS WITHIN 10% FOR BOTH MEAN AND 90%
C PROBABILITY VALUE -- THEREFORE SUFFICIENT SAMPLES OBTAINED
C DETERMINE 95% CONFIDENCE INTERVALS FOR MEAN, STANDARD DEVIATION
.
C AND 10% AND 90% PROBABILITY VALUES
  53 ZMEANL=ZMEAN-STDERR*TDIST((INDEX-15)/5)
      ZMEANU=ZMEAN+STDERR*TDIST((INDEX-15)/5)
      SDL=SD/(SQRT(CHI975((INDEX-15)/5)))
      P10=ZMEAN-1.282*SD
      P10L=ZMEAN-1.282*SDU
```

PROGRAM UNREINF (CONTINUED)

```
      P10U=ZMEAN-1.282*SDL
      P90=ZMEAN+1.282*SD
      P90L=ZMEAN+1.282*SDL
      P90=ZMEAN+1.282*SD
      P90U=ZMEAN+1.282*SDU
      P90U=ZMEAN+1.282*SDU
C
C OUTPUT STATISTICAL PARAMETERS OF INCIPIENT COLLAPSE PRESSURE
      PRINT 100,ZMEAN,ZMEANL,ZMEANU,SD,SDL,SDU,P10,P10L,P10U,
+       P90,P90L,P90U
      PRINT 105,INDEX,STDERR
      GOTO 999
C
C 95% CONFIDENCE INTERVAL IS NOT WITHIN 10% FOR BOTH MEAN AND 90
C
C VALUES -- THEREFORE OBTAIN 5 ADDITIONAL SAMPLES
   61 ICHECK=ICHECK+5
      RETURN
C
 34 FORMAT(/*INPUT MEAN AND STANDARD DEVIATION FOR FR*,*)
 85 FORMAT(/*INPUT MEAN AND STANDARD DEVIATION FOR FPM*,*)
  87 FORMAT(/*INPUT MEAN AND STANDARD DEVIATION FOR S*,*)
 90 FORMAT(F9.2,F11.2,F10.2,F14.3)
 91 FORMAT(F9.1,F15.1,F12.2,F10.2,F14.3)
 94 FORMAT(///,5X,*FR*,10X,*S*,8X,*PSO*,6X,*COLLAPSE TIME*)
 95 FORMAT(///,5X,*FPM*,11X,*EM*,12X,*S*,8X,*PSO*,6X,
+    *COLLAPSE TIME*)
 100 FORMAT(///,11X,*STATISTICAL PROPERTIES OF INCIPIENT PSO*,
+       //,34X,*95% CONFIDENCE LIMITS*,/,7X,*ITEM*,18X,
+       *VALUE       LOWER         UPPER*,//,* MEAN*,F29.2,
+       2F12.2,//,* STANDARD DEVIATION*,F15.2,2F12.2,//,
+       * 10% PROBABILITY VALUE*,3F12.2,//,
+       * 90% PROBABILITY VALUE*,3F12.2)
 105 FORMAT(//,5X,*NUMBER OF OBSERVATIONS =*,I3,/,5X,
+       *STANDARD ERROR =*,F5.2)
C
 999 STOP$ END
FUNCTION XNORM1(X,A,B)
IF(X)10,20,20
10 XO=RANF(-1.0)
20 X1=RANF(0.0)
X2=RANF(0.0)
Y=SQRT(-2.0*ALOG(X1))*(COS(6.283184*X2))
XNORM1=A+Y*B
RETURN
END
```

ADDITION TO PROGRAM UNREINF TO INCLUDE LOAD TYPES 2 THROUGH 5:

```
C      2. TRIANGULAR LOAD
C      3. STEP PULSE
C      4. URS SHOCK TUNNEL LOAD
C      5. ARBITRARY LOAD SHAPE
DIMENSION TT(20),PP(20)
GOTO(1,2,3,4),IENTRY
1 GOTO(100,110,110,120,130),LOTYPE
110 PRINT 610
READ,TR,TO
GOTO 125
120 PRINT 615
READ,TR,T1,TO
125 IF((INC.EQ.1)RETURN
PRINT 630
READ,PSO
RETURN
130 PRINT 620
READ,NPOINT,(TT(I),PP(I),I=1,NPOINT)
```

PROGRAM UNREINF (CONCLUDED)

[illegible]

ARCHING

Unreinforced Masonry Wall With Arching

PROGRAM ARCHING

```
      PROGRAM JIMBOC(INPUT,OUTPUT,TAPE1=OUTPUT)
C:  THIS ROUTINE IS THE CONTROLLING ROUTINE FOR THE PROGRAM USED
C:  IN THE ANALYSIS OF ONE-WAY OR TWO-WAY ACTION WALLS.
C
      COMMON Y(100),YU,YFAIL,Q,QU,AREA,ZMASS,ZKLM,VH1,VH2,VV1,VV2
      COMMON KWALL,KINC,KRF,KRAND,I,ICASE,FU,VFAIL,FR,FPM,EM,FDY
      COMMON FDC,D(4),LDTYPE,PEXT,PF,PSO,PDO,PC,TC,TO,PO,TIME,L,S
      COMMON /RAND/  TIMEC,IWALL
      DIMENSION A(100),V(100),T(100),VV(100),VH(100),
     +  PEX(100),PIN(100),PN(100)
C
C:  READ TITLE AND CONTROL PARAMETERS
    5 PRINT 67
      READ 68,TITLE
      PRINT 85
      READ,KWALL,KINC,LDTYPE,KRF,KRAND
      DELAY=0
      VFAIL=1E10
      CALL RESIST(1)
      CALL FORCE(1)
      IF(KRF.EQ.0)GOTO 12
      CALL FILL(PINT,1)
   12 IF(KWALL.EQ.0)GOTO 14
      PRINT 86
      READ,DELAY
      DELAY=DELAY/1000.0
   14 IF(KRAND.NE.1)GOTO 35
      CALL FORCE(4)
      CALL RANDOM(1)
   34 CALL RANDOM(2)
   35 CALL RESIST(3)
C
C: MINIMUM, MAXIMUM, AND STARTING VALUES ARE DETERMINED FOR CASES
C: WHERE THE LOAD CAUSING INCIPIENT COLLAPSE IS TO BE FOUND
   13 IF(KINC.EQ.0)GOTO 23
       PF=QU
       PFMAX=0
       PFMIN=PF/2.0
      GOTO 20
   16  PF=(PFMIN+PFMAX)/2.0
   20 CALL FORCE(2)
   23 IF(KRF.EQ.0)GOTO 24
      CALL FILL(PINT,2)
C
C: INITIALIZE VALUES FOR BETA METHOD (BETA = 1/6) AND COMPUTE VA U
C: FOR FIRST TIME INTERVAL ASSUMING WALL INITIALLY AT REST
   24  I=1
       TIME=0
      T(1)=0$ V(1)=0$ Y(1)=0
       DELTA=0.001
      IF(KWALL.EQ.0)GOTO 29
   27 IF(TIME.GE.(DELAY-0.00001))GOTO 28
      TIME=TIME+DELTA
      CALL FILL(PINT,3)
      GOTO 27
   28 PIN(1)=PINT
      TPNET=AREA*PINT
      T(1)=TIME
      GOTO 30
   29 CALL FORCE(3)
      PEX(I)=PEXT
      TPNET=AREA*PEXT
       PN(1)=PEXT
   30 CALL RESIST(2)
       A(1)=TPNET/(ZMASS*ZKLM)
       VV(1)=VV1*TPNET
       VH(1)=VH1*TPNET
C
C: PROCEDURE FOR ALL SUBSEQUENT TIME INTERVALS
    1  I=I+1
      IF(I.LT.101)GOTO 11
      PRINT 98,TIME
   98 FORMAT(/,*I=101;  TIME =*,F6.3,*;  WALL ASSUMED TO NOT FAIL*)
      GOTO 6
```

PROGRAM ARCHING (CONTINUED)

```
 11   TIME=TIME+DELTA
       T(I)=TIME
       A(I)=A(I-1)
      CALL FORCE(3)
       PEX(I)=PEXT
      IF(KWALL.EQ.1)GOTO 10
      IF(KRF.EQ.0)GOTO 3
      CALL FILL(PINT,3)
       PIN(I)=PINT
      TPNET=AREA*(PEXT-PINT)
       GOTO 2
 3     TPNET=AREA*PEXT
      GOTO 2
 10   CALL FILL(PINT,3)
      PIN(I)=PINT
      TPNET=AREA*PINT
 2    PN(I)=TPNET/AREA
      DO 8 JJ=1,10
       Y(I)=Y(I-1)+DELTA*V(I-1)+DELTA*DELTA*(A(I-1)/3.+A(I)/6.)
       CALL RESIST(2)
       QT=Q*AREA
 4     ANEW=(TPNET-QT)/(ZMASS*ZKLM)
       ADELTA=ANEW-A(I)
       A(I)=ANEW
 IF(ANEW.EQ.0)PRINT,*1985*,TIME,TPNET,QT,ZMASS,ZKLM,Y(I),A(I-1)
       IF(ABS(ADELTA/ANEW).LT.0.01)GOTO 9
 8     CONTINUE
       A(I)=ANEW-ADELTA/2.0
       WRITE(1,80)TIME,PF,A(I),Y(I)
 9     CONTINUE
       Y(I)=Y(I-1)+DELTA*V(I-1)+DELTA*DELTA*(A(I-1)/3.+A(I)/6.)
       V(I)=V(I-1)+DELTA*(A(I)+A(I-1))/2.0
       VV(I)=VV1*TPNET+VV2*QT
       VH(I)=VH1*TPNET+VH2*QT
      IF(VV(I).GT.VFAIL)GOTO 7
C
C: CHECK FOR MAXIMUM DEFLECTION OR FAILURE OF WALL
C:    IF MAXIMUM DEFLECTION REACHED, WALL DID NOT FAIL
      IF(Y(I).LE.Y(I-1).AND.PN(I).LE.PN(I-1))GOTO 6
      IF(Y(I).LT.0)GOTO 6
      IF(TIME-DELAY.GE.0.010)DELTA=0.002
      IF(Y(I).LT.YU)GOTO 1
      IF(TIME-DELAY.GE.0.020)DELTA=0.005
      IF(TIME-DELAY.GE.0.100)DELTA=0.
      IF(TIME-DELAY.GE.0.500)DELTA=0.L
C   IF FAILURE DEFLECTION REACHED, WALL FAILED
      IF(Y(I).GE.YFAIL)GOTO 7
       GOTO 1
C
C: INTERVAL HALVING PROCEDURE TO DETERMINE LOAD CAUSING INCIPIENT
C: COLLAPSE FOR CASES WHERE DESIRED
C:    WALL DID NOT FAIL - SET PFMIN TO PF
 6     CONTINUE
       IF(KRAND.EQ.1)GOTO 36
       IF(KINC.EQ.0)GOTO 18
 36    PFMIN=PF
        IF(PFMAX.G .0)GOTO 17
        PF=2.0*PF
        GOTO 20
C     WALL FAILED - SET PFMAX TO PF
 7      CONTINUE
        TIMEC=TIME
        IF(KRAND.EQ.1)GOTO 37
        IF(KINC.EQ.0)GOTO 18
 37     PFMAX=PF
C:    CHECK TO SEE IF LOAD RANGE IS WITHIN DESIRED ACCURACY
 17       IF((PFMAX-PFMIN)/PFMIN.GT.0.01)GOTO 16
        IF(KRAND.NE.1)GOTO 18
        CALL RANDOM(3)
        GOTO 34
C
C: OUTPUT DATA INCLUDES THE MAXIMUM DEFLECTION AND TIME OF
C: OCCURANCE FOR A NON-FAILING WALL OR THE TIME AND VELOCITY
C: AT COLLAPSE FOR A FAILING WALL.  OPTIONAL OUTPUT IS THE
```

PROGRAM ARCHING (CONTINUED)

```
C: ENTIRE BEHAVIOR TIME-HISTORY OF THE WALL.
C
C: OUTPUT LOAD DATA
 18    CALL FORCE(4)
C
C: OUTPUT FINAL RESULTS
       IF(Y(I).LT.YFAIL)WRITE(1,70)Y(I),T(I)
       IF(Y(I).GE.YFAIL)WRITE(1,71)T(I),V(I)
C
C: CHECK TO SEE IF ENTIRE TIME-HISTORY OF WALL IS DESIRED
       WRITE(1,72)
 READ,M
       IF(M.EQ.0)GOTO 25
      IF(KWALL.EQ.1)GOTO 32
      IF(KRF.EQ.0)GOTO 26
       WRITE(1,75)(T(J),PEX(J),PIN(J),PN(J),Y(J),VV(J),VH(J),J=1 I)
       GOTO 25
 26    WRITE(1,76)(T(J),PEX(J),A(J),V(J),Y(J),VV(J),VH(J),J=1,I)
      GOTO 25
 32   WRITE(1,76)(T(J),PIN(J),A(J),V(J),Y(J),VV(J),VH(J),J=1,I)
 25    WRITE(1,77)
       GOTO 5
C
 67 FORMAT(/*INPUT TITLE*,+)
 68 FORMAT(A59)
 70 FORMAT(/*WALL DID NOT FAIL - MAX. DEFLECTION OF*F6.2
+     * IN. REACHED AT*F7.3,* SEC*)
 71 FORMAT(/*WALL FAILED AT*,F7.3,* SEC (FINAL VELOCITY =*
+    F7.2* IN./SEC)*)
 72 FORMAT(/*IS TIME HISTORY OF WALL DESIRED (YES=1, NO=0)*,+)
 75 FORMAT(/,15X,*PRESSURE ON WALL*/*  TIME   EXTERIOR  *
+ *INTERIOR    NET     DISPLACEMENT     VV       VH*/
+    (F6.3,3F10.3,F12.4,F11.0,F8.0))
 76 FORMAT(/*  TIME  PRESSURE  ACCELERATION  VELOCITY  *
+    *DISPLACEMENT     VV       VH*/
+    (F6.3,F9.3,F12.1,F12.2,F12.4,F11.0,F8.0))
 77    FORMAT(///,7(*-----------*))
 80 FORMAT(/*ACCELERATION NOT CONVERGING AT TIME =*,F6.3,
+             * SEC (PF =*,F7.3,* PSI)*/*      A(I) SET EQUAL TO
+             F8.1,* (AVG OF LAST 2 ITERATIONS)*/*      Y(I) =*,
+             F8.4,* IN.*)
 85 FORMAT(/*INPUT KWALL(0=EXT,1=INT),KINC,LDTYPE,KRF,KRAND*,
+    *(1=RANDOM)*)
 86 FORMAT(/*INPUT DELAY TIME (MSEC) TO INITIAL LOADING OF*,
+    * INTERIOR WALL*,+)
C
 999    STOP
       END
 SUBROUTINE FORCE(IENTRY)
C  THIS SUBROUTINE INPUTS THE LOAD PARAMETERS AND DETERMINES
C  THE LOAD AT A GIVEN TIME FOR THE FOLLOWING LOAD TYPES:
C      1. IDEALIZED BLAST LOAD (FRONT OR SIDE FACE)
C
 COMMON Y(100),YU,YFAIL,Q,QU,AREA,ZMASS,ZKLM,VH1,VH2,VV1,VV2
 COMMON KWALL,KINC,KRF,KRAND,I,ICASE,FU,VFAIL,FR,FPM,EM,FDY
 COMMON FDC,D(4),LDTYPE,P,PR,PS0,PD0,PC,TC,TO,P0,TIME,LL,S
C
 GOTO(100,200,300,4),IENTRY
C
C  INPUT LOAD PARAMETERS
 100 IF(KRAND.EQ.0)GOTO 102
 W=1000 $ P0=14.7 $ C0=1120.    LOC=1
 RETURN
 102 PRINT 600
 READ,W,P0,C0,LOC,S
 IF(LOC.EQ.1)GOTO 105
 PRINT 605
 READ,ZLEN,CD
 105 IF(KINC.EQ.1)RETURN
 PRINT 630
 READ,PS0
 PR=2.0*PS0*(7.0*P0+4.0*PS0)/(7.0*P0+PS0)
 GOTO 215
C
```

PROGRAM ARCHING (CONTINUED)

```
11010C  CALCULATE LØAD PRØPERTIES FØR GIVEN PEAK PRESSURE
11030 200 GØTØ(205,210),LØC
11040 205 PSØ=(PR-14.0*PØ+SQRT(196.0*PØ*PØ+196.0*PØ*PR+PR*PR))/16.0
11050 GØTØ 215
11060 210 PSØ=PR
11070 215 PDØ=2.5*PSØ*PSØ/(7.0*PØ+PSØ)
11080 U=CØ*SQRT(1.0+(6.0*PSØ)/(7.0*PØ))
11090 TO=W**0.3333/(2.2399+0.1886*PSØ)
11100 GØTØ(220,225),LØC
11110 220 TC=3.0*S/U
11120 PC=PSØ*(1-TC/TO)*EXP(-TC/TO)+PDØ*(1-TC/TO)**2*EXP(-2*TC/TO)
11130 CD=1.0
11140 RETURN
11150 225 TA=ZLEN/U
11160 TA2=TA/2.0
11170 TA2TO=TA2/TO
11180 PA=PSØ*(1-TA2TO)*EXP(-TA2TO)+CD*PDØ*(1-TA2TO)**2*EXP(-2*TA2TO)
11190 RETURN
12000C
12010C  CALCULATE LØAD
12030 300 GØTØ(305,310),LØC
12040 305 TTO=TIME/TO
12050 IF(TIME.GT.TC)GØTØ 320
12060 P=PC+(TC-TIME)*(PR-PC)/TC
12070 RETURN
12080 310 TTO=(TIME-TA2)/TO
12090 IF(TIME.GT.TA)GØTØ 320
12100 P=PA*TIME/TA
12110 RETURN
12120 320 IF(TTO.GE.1.0)GØTØ 330
12130 P=PSØ*(1-TTO)*EXP(-TTO)+CD*PDØ*(1-TTO)**2*EXP(-2*TTO)
12150 RETURN
12160 330 P=0
12170 RETURN
13000C
13010C  PRINT LØAD DATA
13020 4 IF(KINC.EQ.0)GØTØ 400
13030 PRINT 640,LDTYPE
13040 GØTØ 410
13050 400 PRINT 645,LDTYPE
13060 410 CØNTINUE
13070 415 GØTØ(420,425),LØC
13080 420 PRINT 650
13090 GØTØ 430
13100 425 PRINT 655
13110 430 PRINT 660,W,PØ,CØ
13120 IF(KRAND.NE.0)RETURN
13130 GØTØ(435,440),LØC
13140 435 PRINT 665,S,TC,PR
13150 GØTØ 445
13160 440 PRINT 670,ZLEN,TA,PA
13170 445 PRINT 675,U,TO,CD,PSØ,PDØ
13180 RETURN
14000C
14010 600 FØRMAT(/*INPUT W,PØ,CØ,LØC,S*,*)
14020 605 FØRMAT(/*INPUT L,CD*,*)
14060 630 FØRMAT(/*INPUT PSØ*,*)
14070 640 FØRMAT(/*LØAD CAUSING INCIPIENT FAILURE IS AS FØLLØWS:*,
14071*      /,5X,*LØAD TYPE NUMBER*,I2)
14080 645 FØRMAT(/*PRØPERTIES ØF LØAD ACTING ØN WALL ARE AS FØLLØWS:*
14081*      /,5X,*LØAD TYPE NUMBER*,I2)
14090 650 FØRMAT(8X,*(FRØNT FACE)*)
14100 655 FØRMAT(8X,*(SIDE FACE)*)
14110 660 FØRMAT(10X,*W =*,F8.1,* KT    PØ =*,F6.2,* PSI      CØ =*,
14111*      F7.1,* FPS*)
14120 665 FØRMAT(10X,*S =*,F6.1,* FT      TC =*,F6.3,* SEC      PR =*,
14121*      F7.3,* PSI*)
14130 670 FØRMAT(10X,*L =*,F6.1,* FT      TA =*,F6.3,* SEC      PA =*,
14131*      F7.3,* PSI*)
14140 675 FØRMAT(10X,*U =*,F7.1,* FPS    TO =*,F6.3,* SEC      C  =*
14141*      F5.1,/,8X,*PSØ =*,F7.3,* PSI  PDØ =*,F7.3,* PSI*)
15000 END
20000 SUBRØUTINE FILL(P3,IENTRY)
20010C: CØMPUTES AVERAGE AIR PRESSURE IN RØØM DUE TØ BLAST WAVE
```

```
C: INCIDENT HEAD-ON UPON FRONT WALL.
C
      COMMON Y(100),YU,YFAIL,Q,QU,AREA,ZMASS,ZKLM,VH1,V.2,VV1,VV2
      COMMON KWALL,KINC,KRF,KRAND,II,ICASE,FU,VFAIL,FR,FPM,EM,FDY
      COMMON FDC,D(4),LDTYPE,PEXT,PR,PSO,PDO,PC,TC,TO,PO,TIME,L,S
      DIMENSION AA(8,2),NN(8)
      LOGICAL L1,L2,L3
      GOTO(10,13,11),IENTRY
   10 PRINT 700
      RHOO=0.076 $ L1=.FALSE.
      READ,NWIN,V3
      AT=0$ AFRONT=0$ ASIDE=0
      DO 18 I=1,NWIN
      PRINT 710,I
      READ,AA(I,1),NN(I),AA(I,2)
      AA(I,2)=AA(I,2)/1000.0
      AT=AT+AA(I,1)
      M=NN(I)$ GOTO(12,14,14),M
   12 AFRONT=AFRONT+AA(I,1)
      GOTO 18
   14 ASIDE=ASIDE+AA(I,1)
   18 CONTINUE
      AFRONT=AFRONT/AT$ ASIDE=ASIDE/AT
  700 FORMAT(/*INPUT NWIN AND ROOM VOLUME (CF)*,+)
  710 FORMAT(/*INPUT AREA (SQ FT),LOCATION CODE & DELAY(MSEC)*
     + * FOR WINDOW*,I2,+)
      G=1.4 $ G2=1./G $ G3=1.-G2 $ G4=2./G3 $ G5=G+1.
      G6=2.*G/G5 $ G7=(G-1.)/G5
      PP2=.1912
      C=SQRT(G*PO*32.*144./RHOO)
      TAU=2.*(V3**(1./3.))/C
      NSTEP=4
      DT=TAU/NSTEP
      RETURN
C
   13 P3O=PO
      TT=0.$ TO=0.
      RHO3O=RHOO
      L2=.FALSE. $ L3=.FALSE.
      RETURN
C
   11 IF(L1)GOTO 52
      IF(L2.A.L3)GOTO 9
   52 DDT=(TIME-T3)*0.5
      ISTOP=2
   53 IF(DDT.LT.DT)GOTO 51
   50 DDT=0.5*DDT
      ISTOP=2*ISTOP
      GO TO 53
   51 CONTINUE
      DO 99 I=1,ISTOP
      TT=TO+I*DDT
      IF(TT.GT.TO)GO TO 99
      DM=0. $ WW=0. $ NW=0
      DO 500 K=1,NWIN
      M=NN(K) $ DLY=AA(K,2)+0.000001
      IF(DLY.GE.TT)GO TO 500
      GOTO(15,16,16),M
   15 CDF=1.0
      IF(TT-TC)20,20,21
   20  P11=(TC-TT)*(PR-PC)/TC+PC
      P11=P11+PO
      GO TO 30
   16 CDF=-0.4
   21  R=TT/TO $ RR=1.-R
      PD=PDO*RR*RR*EXP(-2.*R)
      PS=PSO*RR*EXP(-R)
      P11=PS+CDF*PD
      P11=P11+PO
   30  RHO1=RHOO*((P11/PO)**G2)
      IF(P11-P3O)36,36,37
   36  JSIGN=-1
      L2=.TRUE.
  303  P2=P11
```

PROGRAM ARCHING (CONTINUED)

```
RHO2=((P2/P30)**G2)*RHO30
X=P30/RHO30
GO TO 38
37  JSIGN=+1
306 P2=Cr2*P11
RHO2=((P2/P11)**G2)*RHO1
X=P11/RHO1
38  U22=G4*(X-P2/RHO2)*32.*144.
IF(U22)40,39,39
40  PRINT,*U22 NEGATIVE*,U22
STOP
39  U2=SQRT(U22)*JSIGN
DDM=U2*RHO2*AA(K,1)*DDT
DM=DM+DDM
WW=WW+P11*DDM/(G_*RHO1)
500 CONTINUE
P30=P30+(G-1.)*WW/V3
RHO30=RHO30+DM/V3
99  CONTINUE
TO=TT
P3=P30-P0
IF(TIME.GE.TC)L3=.TRUE.
RETURN
9 R=TIME/TO $ RR=1.0-R
PD=PD0*RR*RR*EXP(-2.0*R)
PS=PS0*RR*EXP(-R)
P3=PS+PD*(AFRONT-0.4*ASIDE)
999 RETURN
END
SUBROUTINE RESIST (IENTRY)
C
C THIS SUBROUTINE INPUTS THE REQUIRED DATA AND COMPUTES VARIOUS
C QUANTITIES USED IN THE ANALYSIS OF WALLS WITH ONE-WAY ARCHING
C (SUPPORT CASE 9) OR TWO-WAY ARCHING (SUPPORT CASE 10)
C
      COMMON Y(100),YU,YFAIL,Q,QU,AREA,ZMASS,ZKLM,VH1,VH2,VV1,VV2
      COMMON KWALL,KINC,KSF,KRAND,I,ICASE,FU,VFAIL,FR,FPM,EM,FDY
      COMMON FDC,D(4),LDTYPE,PEXT,PF,PS0,PD0,PC,TC,TO,P0,TIME,L,S
      COMMON /RAND/ TIMEC,IWALL
C
      GOTO(1,99,2),IENTRY
C
C INPUT WALL DATA
    1 PRINT 60
      READ,ZLV,ZLH,TW,TFLG,EM,FPM,ICASE,ZLVW,ZLHW,GAMMA
C
C DETERMINE VALUES OF VARIOUS CONSTANTS
      IWALL=2
      ZL2=ZLV/2.0
      AWALL=ZLV*ZLH
      AWIN=ZLVW*ZLHW
      AREA=AWALL-AWIN
      ZMASS=GAMMA*AREA*TW/(386.07*1728.0)
      RATIO=ZLV/ZLH
      IF(ICASE.EQ.9)RATIO=0
      BETA=0.5*(SQRT(3.0*RATIO**2+RATIO**4) RATIO**2)
      ZKLM=(2.0-2.0*BETA)/(3.0-2.0*BETA)
      VV1=BETA/6.0
      VV2=BETA/3.0
      VH2=(3.0-4.0*BETA)**2/(12.0*(2.0-3.0*BETA))
      VH1=(1.0-BETA)/2.0-VH2
      ZLD=SQRT(ZL2*ZL2+TW*TW)
      EP[illegible]=(ZLD-ZL2)/ZLD
      C2=2.0-4.0*BETA
      C3=0
      IF(RATIO.EQ.0)GOTO 9
      C3=4.0*BETA+RATIO**2/BETA
    9 CONTINUE
      C4=12.0/(ZLV*ZLV*(3.0-2.0*BETA))
      YFAIL=TW
C
C  DETERMINE MODIFICATION FACTOR FOR WALL WITH WINDOWS
C
      QMULT=1.0
```

```
       IF(AWIN.NE.0)CALL WINDOW (QMULT, ZLV, ZLH, ZLVW, ZLHW, AWIN,
+         AWALL, RATIO, ICASE)
C
C  OUTPUT WALL PROPERTIES
       PRINT 62, ICASE, ZLV, ZLH, RATIO, TW, EM, FPM, GAMMA, TFLG, ZLVW,
+         ZLHW, QMULT
       RETURN
C
     2 YU=TW*FPM/(EM*EPSM)
       TFLG2=2.0*TFLG
       IF(TFLG.NE.0)GOTO 3
C
C SOLID MASONRY WALL
     5 ZMU=0.25*FPM*(TW-YU)**2
       C1=0.5*ZMU*YU+FPM*(TW-YU)**3/12.0
       GOTO 4
C
C HOLLOW MASONRY UNIT WALL
     3 Y2=TW-2.0*TFLG
       IF(YU.LT.Y2)GOTO 6
C YU>Y2 -- TREAT WALL AS SOLID WALL
       TFLG2=0$ GOTO 5
     6 PFLG=FPM*TFLG
       TWF=TW-TFLG
       ZMU=PFLG*(TWF-YU)
       ZM2=PFLG*TFLG
       C6=0.5*(ZMU*YU+PFLG*(TWF-YU)**2)
       C7=C6+FPM*TFLG**3/6.0
     4 QU=8.0*ZMU/(ZLV*ZLV)
       RETURN
C
    60 FORMAT(//*INPUT LV,LH,TW,TFLG,EM,FPM,ICASE,LVW,LHW,GAMMA*)
    62 FORMAT(//*PROPERTIES OF UNREINFORCED MASONRY WALL (ARC-ING)
+         * -- SUPPORT TYPE NO.*,I3,
+         /,6X,*LV =*,F6.1,* INCHES*,6X,*LH =*,F6.1,
+         * INCHES     RATIO =*,F6.3,/6X,*TW =*,F5.1,* INCHES*,
+         7X,*EM =*,F10.1,* PSI    FPM =*,F8.2,* PSI*,/,3X,
+         *GAMMA =*,F6.1,* PCF*,7X,*TFLG =*,F6.3,* INCHES*,/,
+         5X,*LVW =*,F6.1,* INCHES*,5X,*LHW =*,F6.1,* INCHES*,
+         5X,*QMULT =*,F6.3)
C
C  DETERMINE THE RESISTANCE FOR THE WALL AT A DEFLECTION OF Y(I)
    99 IF(Y(I).GT.YU)GOTO 100
C
C DEFLECTION OF WALL LESS THAN YU
       ZMC=Y(I)*ZMU/YU
       ZMAVG=0.5*ZMC
       GOTO 130
C
C DEFLECTION OF WALL GREATER THAN YU
   100 IF(TFLG2.NE.0)GOTO 110
       ZMC=0.25*FPM*(TW-Y(I))**2
       ZMAVG=(C1-FPM*(TW-Y(I))**3/12.0)/Y(I)
       GOTO 130
C
C HOLLOW MASONRY UNIT WALL -- DEFLECTION LESS THAN Y2
   110 IF(Y(I).GT.Y2)GOTO 120
       ZMC=PFLG*(TWF-Y(I))
       ZMAVG=(C6-0.5*PFLG*(TWF-Y(I))**2)/Y(I)
       GOTO 130
C
C HOLLOW MASONRY UNIT WALL -- DEFLECTION GREATER THAN Y2
   120 ZMC=0.25*FPM*(TW-Y(I))**2
       ZMAVG=(C7-(TW-Y(I))**2/12.0)/Y(I)
       GOTO 130
C
C COMPUTE TOTAL RESISTANCE OF WALL
   130 Q=C4*(C2*ZMC+C3*ZMAVG)*QMULT
C      IF DEFLECTION IS GREATER THAN WALL THICKNESS, RESISTANCE = 0
       IF(Y(I).GT.TW)Q=1E-10
       RETURN
       END
       SUBROUTINE WINDOW(QMULT,ZLV,ZLH,ZLVW,ZLHW,AWIN,AWALL,R,ICASE)
C
```

PROGRAM ARCHING (CONTINUED)

```
60020C: THIS SUBROUTINE DETER'T'JES THE STRUCTURAL
60030C: MODIFICATION FACTOR FOR WALLS WITH WINDOWS
60035 IF(ICASE.GT.4.AND.ICASE.NE.10)GOTO 320
60040 RWWS=ZLVW/ZLV
60050 RWWL=ZLHW/ZLH
60060 RAREA=AWIN/AWALL
60070 IF(R.LE.1.5)GOTO 300
60080 IF(RWWS.GT.0.7)GOTO 300
60090 IF(RWWL.LT.0.5)GOTO 300
60100 IF(RWWS.EQ.RWWL)GOTO 300
60110C
60120C:  CASE WHERE LV/LH >= 1.5, LVW/LV <= 0.7, AND LHW/LH >= 0.5
60130C:  (BUT LVW/LV NOT EQUAL TO LHW/LH)
60140 QMULT=-5.85461-12.6644*RAREA+4.39662*RWWS+0.84843*RWWL
60150+      -0.223*R-1.07269*(ZLVW/ZLHW)**0.9+6.59942*EXP(RAREA)
60160 GOTO 315
60170C
60180C:  CASE WHERE ONE OR MORE OF ABOVE CONDITIONS IS NOT MET
60190 300 QMULT=0.62022-2.23415*RAREA**(RWWL**4)-0.79461*RWWL**2
60200+       -2.27663*RWWL+0.62522*RWWL/RAREA**0.3
60210+       +2.63043*EXP(RAREA)-0.09268*RWWS
60220 315 CONTINUE
60230 RETURN
60240C
60250C ONE-WAY ACTION WALLS
60260 320 QMULT=(AWALL-ZLV*ZLHW)/(AWAL`-AW N)
60270 RETURN
60280 END
70000        SUBROUTINE RANDOM (IENTRY)
70010C THIS SUBROUTINE INPUTS MEAN AND STANDARD DEVIATIONS FOR RANDOM
70020C VARIABLES;  GENERATES RANDOM VALUES;  AND CONTROLS REQUIRED
70030C NUMBER OF CASES TO BE RUN;  AND OUTPUTS FINAL RESULTS AND SUMMARY
70040C
70050        COMMON Y(100),YU,YFAIL,Q,QU,AREA,ZMASS,ZKLM,VH1,VH2,VV1,VV2
70060        COMMON KWALL,KINC,KRF,KRAND,I,ICASE,FU,VFAIL,FR,FPM,EM,FDY
70070        COMMON FDC,D(4),LDTYPE,PEXT,PF,PSO,PDO,PC,TC,TO,PO,TIME,L,S
70080        COMMON /RAND/ TIMEC,IWALL
70090        DIMENSION CHI25(7),CHI975(7),TDIST(7)
70100C
70110C VALUES FOR 97.5%  (F=19,24,29,34,39,44,49)
70120        DATA CHI25/.4688,.5167,.5533,.5825,.6065,.6267,.6440/
70130        DATA CHI975/1.7295,1.6402,1.5766,1.5284,1.4903,1.4591,1.4331/
70140        DATA TDIST/2.093,2.064,2.045,2.032,2.022,2.016,2.010/
70150C
70160        GOTO(5,50,70),IENTRY
70170     5 XDUMMY=XNORM1(-1.0,0.0,1.0)
70180C INITIALIZE RANDOM NUMBER GENERATOR
70190        PRINT, /,*INPUT NRAND*,
70200        READ,NRAND
70210        DO 47 I=1,NRAND
70220        XDUMMY=XNORM1(0.0,0.0,1.0)
70230    47 CONTINUE
70240        INDEX=0$  SPSO=0$  SSPSO=0
70250        ICHECK=20
70260C
70270C  INPUT MEAN AND STANDARD DEVIATION FOR RANDOM VARIABLES
70280        PRINT 87
70290        READ,SMEAN,SSD
70300        GOTO(10,20),IWALL
70310C  UNREINFORCED WALLS WITHOUT ARCHING
70320  10  PRINT 84
70330        READ,FRMEAN,FRSD
70340        PRINT 94
70350        RETURN
70360C  UNREINFORCED WALLS WITH ARCHING
70370  20  PRINT 85
70380        READ,FPMMEAN,FPMSD
70390        PRINT 95
70400        RETURN
70460C
70470C  GENERATE RANDOM VALUES
70480  50  GOTO(52,54),IWALL
70490  52  FR=XNORM1(0.0,FRMEAN,FRSD)
70500        IF(FR.LE.0)GOTO 52
```

PROGRAM ARCHING (CONTINUED)

```
      GOTO 58
 54   FPM=XNORM1(0.0,FPMMEAN,FPMSD)
      IF(FPM.LE.0)GOTO 54
 55   ALPHA=XNORM1(0.0,1.0,0.3)
      IF(ALPHA.LT.0.4.OR.ALPHA.GT.1.6)GOTO 55
      EM=1000.0*ALPHA*FPM
 58   IF(SMEAN.EQ.0)GOTO 65
 60   S=XNORM1(0.0,SMEAN,SSD)
      IF(S.LE.0)GOTO 60
 65   INDEX=INDEX+1
      RETURN
C SUM VALUES OF PS0 AND PS0**2 FOR USE IN STATISTICAL ANALYSIS
 70   SPS0=SPS0+PS0
      SSPS0=SSPS0+PS0*PS0
C
C OUTPUT FINAL RESULTS
      GOTO(72,74),IWALL
 72   PRINT 90,FR,S,PS0,TIMEC
      GOTO 80
 74   PRINT 91,FPM,EM,S,PS0,TIMEC
      GOTO 80
 80   IF(INDEX.LT.ICHECK)RETURN
C
C DETERMINE MEAN, STANDARD DEVIATION, AND STANDARD ERROR FOR PS0
      ZN0=INDEX
      ZMEAN=SPS0/ZN0
      SD=SQRT((SSPS0-ZN0*ZMEAN*ZMEAN)/ZN0)
      STDERR=SD/(SQRT(ZN0-1))
C CHECK IF MAXIMUM OF 50 PS0 SAMPLES OBTAINED
      IF(INDEX.EQ.50)GOTO 62
C CHECK IF 95% CONFIDENCE INTERVAL FOR MEAN PS0 VALUE IS
      IF(STDERR*TDIST((INDEX-15)/5)/ZMEAN.GT.0.10)GOTO 61
C
C CONFIDENCE INTERVAL IS WITHIN 10% -- DETERMINE UPPER LIMIT OF
C 95% CONFIDENCE INTERVAL FOR STANDARD DEVIATION
C PROBABILITY VALUE AND ITS 95% CONFIDENCE INTERVAL UPPER LIMIT
  62  SDU=SD/(SQRT(CHI25((INDEX-15)/5)))
C CHECK IF MAXIMUM OF 50 PS0 SAMPLES OBTAINED
      IF(INDEX.EQ.50)GOTO 53
C CHECK IF UPPER VALUE OF 95% CONFIDENCE INTERVAL FOR STANDARD
C DEVIATION IS WITHIN 0.10*MEAN OF THE STANDARD DEVIATION
      IF(((SDU-SD)/ZMEAN).GT.0.10)GOTO 61
C
C 95% CONFIDENCE INTERVAL IS WITHIN 10% FOR BOTH MEAN AND 90%
C PROBABILITY VALUE -- THEREFORE SUFFICIENT SAMPLES OBTAINED
C DETERMINE 95% CONFIDENCE INTERVALS FOR MEAN, STANDARD DEVIATION
,
C AND 10% AND 90% PROBABILITY VALUES
  53  ZMEANL=ZMEAN-STDERR*TDIST((INDEX-15)/5)
      ZMEANU=ZMEAN+STDERR*TDIST((INDEX-15)/5)
      SDL=SD/(SQRT(CHI975((INDEX-15)/5)))
      P10=ZMEAN-1.282*SD
      P10L=ZMEAN-1.282*SDU
      P10U=ZMEAN-1.282*SDL
      P90=ZMEAN+1.282*SD
      P90L=ZMEAN+1.282*SDL
      P90=ZMEAN+1.282*SD
      P90U=ZMEAN+1.282*SDU
      P90U=ZMEAN+1.282*SDU
C
C OUTPUT STATISTICAL PARAMETERS OF INCIPIENT COLLAPSE PRESSURE
      PRINT 100,ZMEAN,ZMEANL,ZMEANU,SD,SDL,SDU,P10,P10L,P10U,
+       P90,P90L,P90U
      PRINT 105,INDEX,STDERR
      GOTO 999
C
C 95% CONFIDENCE INTERVAL IS NOT WITHIN 10% FOR BOTH MEAN AND 90
B
C VALUES -- THEREFORE OBTAIN 5 ADDITIONAL SAMPLES
  61  ICHECK=ICHECK+5
      RETURN
C
  84  FORMAT(/*INPUT MEAN AND STANDARD DEVIATION FOR FR*,/)
  85  FORMAT(/*INPUT MEAN AND STANDARD DEVIATION FOR FPM*,/)
```

PROGRAM ARCHING (CONTINUED)

```
71280   87 FØRMAT(/*INPUT MEAN AND STANDARD DEVIATIØN FØR S*,*)
71290  90 FØRMAT(F9.2,F11.2,F10.2,F14.3)
71300  91 FØRMAT(F9.1,F15.1,F12.2,F10.2,F14.3)
71320  94 FØRMAT(///,5X,*FR*,10X,*S*,8X,*PSØ*,6X,*CØLLAPSE TIME*)
71330  95 FØRMAT(///,5X,*FPM*,11X,*EM*,12X,*S*,8X,*PSØ*,6X,
71340+     *CØLLAPSE TIME*)
71360  100 FØRMAT(///,11X,*STATISTICAL PRØPERTIES ØF INCIPIENT PSØ*,
71370+        //,39X,*95% CØNFIDENCE LIMITS*, /,7X,*ITEM*,18X,
71380+        *VALUE        LØWER        UPPER*, //,* MEAN*,F29.2,
71390+        2F12.2,//,* STANDARD DEVIATIØN*,F15.2,2F12.2, //,
71400+        * 10% PRØBABILITY VALUE*,3F12.2,//,
71410+        * 90% PRØBABILITY VALUE*,3F12.2)
71420  105 FØRMAT(//,5X,*NUMBER ØF ØBSERVATIØNS =*,I3, /,5X,
71430+        *STANDARD ERRØR =*,F5.2)
71440C
71450  999 STØP$ END
71460 FUNCTIØN XNØRM1(X,A,B)
71470 IF(X)10,20,20
71480 10 XO=RANF(-1.0)
71490 20 X1=RANF(0.0)
71500 X2=RANF(0.0)
71510 Y=SQRT(-2.0*ALØG(X1))*(CØS(6.283184*X2))
71520 XNØRM1=A+Y*B
71530 RETURN
71540 END
```

ADDITIØN TØ PRØGRAM ARCHING TØ INCLUDE LØAD TYPES 2 THRØUGH 5:

```
10040C      2. TRINGULAR LØAD
10050C      3. STEP PULSE
10060C      4. URS SHØCK TUNNEL LØAD
10070C      5. ARBITRARY LØAD SHAPE
10120 DIMENSIØN TT(20),PP(20)
10150 GØTØ(1,2,3,4),IENTRY
10180 1 GØTØ(100,110,110,120,130),LDTYPE
10290 110 PRINT 610
10300 READ,TR,TO
10310 GØTØ 125
10320 120 PRINT 615
10330 READ,TR,T1,TO
10340 125 IF(KINC.EQ.1)RETURN
10350 PRINT 630
10360 READ,PSØ
10370 RETURN
10380 130 PRINT 620
10390 READ,NPØINT,(TT(J),PP(J),J=1,NPØINT)
10400 FACTØR=1.0
10410 IF(KINC.EQ.0)GØTØ 150
10420 PMAX=PP(1)
10430 DØ 140 J=2,NPØINT
10440 140 IF(PP(J).GT.PMAX)PMAX=PP(J)
10450 150 PX=PP(2)-PP(1)
10460 TX=TT(2)-TT(1)
10465 JJ=1
10470 RETURN
11020 2 GØTØ(200,230,230,230,240),LDTYPE
11200 230 PSØ=PR
11210 RETURN
11220 240 FACTØR=PR/PMAX
11225 GØTØ 150
11230 RETURN
12020 3 GØTØ(300,340,360,370,380),LDTYPE
12180 340 IF(TIME-TR)342,345,345
12190 342 P=PSØ*TIME/TR
12200 RETURN
12210 345 IF(TIME-TO)347,350,350
12220 347 P=PSØ*(TO-TIME)/(TO-TR)
```

PROGRAM ARCHING (CONCLUDED)

```
RETURN
350 P=0
RETURN
360 IF(TIME-TR)342,362,362
362 IF(TIME-TO)364,364,350
364 P=PSØ
RETURN
IF(TIME-TR)342,372,372
372 IF(TIME-T1)364,364,374
374 IF(TIME-TC)376,376,350
376 P=PSØ*(TO-TIME)/(TC-T1)
RETURN
380 IF(TIME.LE.TT(JJ+1))GØTØ 385
JJ=JJ+1
PX=PP(JJ+1)-PP(JJ)
TX=TT(JJ+1)-TT(JJ)
GØTØ 380
385 P=FACTØR*(PP(JJ)+(TIME-TT(JJ))*PX/TX)
RETURN
410 GØTØ(415,450,450,460,470),LDTYPE
450 PRINT 680,TR,TO,PSØ
RETURN
460 PRINT 685,TR,T1,TO,PSØ
RETURN
470 DØ 480 J=1,NPØINT
P=FACTØR*PP(J)
480 PRINT 690,TT(J),P
RETURN
610 FØRMAT(/*INPUT TR,TO*,t)
615 FØRMAT(/*INPUT TR,T1,TO*,t)
620 FØRMAT(/*INPUT NUMBER ØF LØAD PØINTS AND THE TIME AND *,
+    *PRESSURE AT EACH PØINT*)
680 FØRMAT(/10X,*TR =*,F6.3,* SEC   TO =*,F6.3,* SEC   PSØ =*,
+    F7.3,* PSI*)
685 FØRMAT(/10X,*TR =*,F6.3,* SEC   T1 =*,F6.3,* SEC    TO =*,
+    F6.3,* SEC*,/,9X,*PSØ =*,F7.3,* PSI*)
690 FØRMAT(F15.3,F12.2)
695 FØRMAT(/10X,*TIME      PRESSURE*)
```

RCWALL

Reinforced Concrete Wall

PROGRAM RCWALL

```
00100 PROGRAM RCWALL1 (INPUT,OUTPUT)
00105 CALL RETR(7HRCWALL2,7HRCWALL2)
00110C: THIS PORTION OF THE PROGRAM INPUTS THE REQUIRED WALL AND LOAD
00115C: DATA AND INITIALIZES CERTAIN PARAMETERS
00120C
00150 COMMON KWALL,KINC,LDTYPE,KRF,KRAND,TIME,I,Y(100),Q,QU,YU,YFAIL,
00152+  ZLV,ZLH,TW,PV,FPC,FDY,ICASE,NOBAR,AS(4),APS(4),D(4),DP(4),FDC,
00154+  EC,ES,R,ALP,ALP2,AREA,ZMASS,QMULT,VFAIL,ZKLM,VH1,VH2,VV1,VV2,
00156+  W,PO,CO,LOC,S,ZLEN,CD,PSO,PDO,PR,PEXT,PC,TC,TO,DELAY,
00158+  NWIN,RHOO,VOL1,AA(8,2),NN(8),AFRONT,ASIDE,G,G2,G3,G4,PP2,DT
00165C
00170C:  READ TITLE AND CONTROL PARAMETERS
00175 PRINT 67
00180 READ 65,TITLE
00185 PRINT 85
00190 READ,KWALL,KINC,LDTYPE,KRF,KRAND
00195 DELAY=0
00200 VFAIL=1E10
00205 67 FORMAT(/*INPUT TITLE*,+)
00210 65 FORMAT(A59)
00215 85 FORMAT(/*INPUT KWALL(0=EXT,1=INT),KINC,LDTYPE,KRF,KRAND*,
00220+   *(1=RANDOM)*)
00225C
00230C: * DETERMINE WALL PROPERTIES INDEPENDENT OF FDC,FDY, AND D
00235C
00240 4 DO 5 I=1,4
00245 AS(I)=0
00250 5 CONTINUE
00255C
00260C: * INPUT AND ECHO WALL AND REINFORCEMENT PROPERTIES *
00270 PRINT 615
00275 READ,ZLV,ZLH,TW,PV,FPC,FDY,ICASE,ZLVW,ZLHW,NOBAR
00280 FDC=1.25*FPC
00285 EC=57619.0*SQRT(FPC)
00290 ES=29E6
00295 ECKIP=EC/1000$ ESKIP=ES/1000
00300 R=ZLH/ZLV
00305 ALP=1.0/R$ ALP2=ALP*ALP
00310 IF(ICASE.LE.4)GOTO 11
00315 R=0$ ALP=0$ ALP2=0
00320 11 PRINT 670
00325 DO 8 I=1,4
00330 PRINT 625,I
00335 READ,AS(I),D(I),APS(I),DP(I)
00350 IF(I.NE.1)GOTO 3
00355 GOTO(8,8,8,8,9,7,7),ICASE
00360 3 GOTO(9,8,7,6,9,9,9),ICASE
00365 6 IF(I.EQ.3)GOTO 9
00370 GOTO 8
00375 7 I=I+1
00380 8 CONTINUE
00385 9 CONTINUE
00390C
00395C: ***********************************************
00400C: * DETERMINE DEFLECTION AND MOMENT COEFFICIENTS *
00405C: ***********************************************
00410C
00415 AWALL=ZLV*ZLH
00420 AWIN=ZLVW*ZLHW
00425 AREA=AWALL-AWIN
00430 ZMASS=150.0*AREA*TW/(386.07*1728.0)
00435 QMULT=1.0
00440 IF(AWIN.NE.0)CALL WINDOW (QMULT,ZLV,ZLH,ZLVW,ZLHW,AWIN,AWALL,
00441+      R,ICASE)
00445 PRINT 620,ICASE,ZLV,ZLH,ALP,TW,FPC,ECKIP,FDY,ESKIP,PV,
00450+  ZLVW,ZLHW,QMULT
00455 PRINT 630
00460 DO 110 I=1,4
00465 IF(AS(I).EQ.0)GOTO 110
00467 P=AS(I)/(12.0*D(I)) $ PP=APS(I)/(12.0*D(I))
00470 PRINT 640,I,AS(I),P,D(I),APS(I),PP,DP(I)
00475C  CHANGE UNITS OF REINFORCEMENT FROM SQ.IN./FT TO SQ.IN./IN.
00480 AS(I)=AS(I)/12.0
00485 APS(I)=APS(I)/12.0
```

PROGRAM RCWALL (CONTINUED)

```
110 CONTINUE
615 FORMAT(/*INPUT LV,LH,TW,PV,F'C,FDY,ICASE,LVW,LHW,NOBAR*)
620 FORMAT(//*PROPERTIES OF REINFORCED CONCRETE WALL --*,
+      * SUPPORT TYPE NO.*,I2,/,
+      *  LV =*,F6.1,* IN.     LH =*,F6.1,* IN.   LV/LH =*,
+      F5.2/  *  TW =*,F6.1,* IN.     F'C =*,F7.1,* PSI*,5X,
+      *EC =*,F7.1,* KSI*,/,* FDY =*,F8.1,* PSI   ES =*,
+      F8.1,* KSI     PV =*,F6.1,* LB/IN.*/
+      * LVW =*,F6.1,* IN.     LHW =*,F6.1,* IN.   QMULT =*,F6.3)
625 FORMAT(*INPUT AS,D,A'S,&D' FOR SECTION*,I2,+)
630 FORMAT(//*REINFORCEMENT VALUES*/* SECTION     AS      (P)*,
+      9X,*D*,8X,*A'S     (P')*,8X,*D'*,/,8X,*(SQ.IN./FT.)*,8X,
+      *(IN.)    (SQ.IN./FT.)*,8X,*(IN.)*)
640 FORMAT(I5,F11.4,* (*,F6.4,*)*,F9.3,F10.4,* (*,F6.4,*)*,F9.3)
670 FORMAT(1H )
C
C  INPUT LOAD PARAMETERS
IF(LDTYPE.EQ.5)GOTO 25
100 IF(KRAND.EQ.0)GOTO 102
W=1000.0 $ PO=14.7 $ CO=1120.0 $ LOC=1
GOTO 106
102 PRINT 600
READ,W,PO,CO,LOC,S
IF(LOC.EQ.1)GOTO 105
PRINT 605
READ,ZLEN,CD
105 IF(KINC.EQ.1)GOTO 106
PRINT 610
READ,PSO
PR=2.0*PSO*(7.0*PO+4.0*PSO)/(7.0*PO+PSO)
600 FORMAT(/*INPUT W,PO,CO,LOC,S*,+)
605 FORMAT(/*INPUT L,CD*,+)
610 FORMAT(/*INPUT PSO*,+)
C
C * INPUT ROOM-FILLING PARAMETERS *
106 IF(KRF.EQ.0)GOTO 20
10 PRINT 700
RHOO=0.076 $ L1=.FALSE.
READ,NWIN,V3
AT=0$ AFRONT=0$ ASIDE=0
DO 18 I=1,NWIN
PRINT 710,I
READ,AA(I,1),NN(I),AA(I,2)
AA(I,2)=AA(I,2)/1000.0
AT=AT+AA(I,1)
M=NN(I)$ GOTO(12,14,14),M
12 AFRONT=AFRONT+AA(I,1)
GOTO 18
14 ASIDE=ASIDE+AA(I,1)
18 CONTINUE
AFRONT=AFRONT/AT$ ASIDE=ASIDE/AT
700 FORMAT(/*INPUT NWIN AND ROOM VOLUME (CF)*,+)
710 FORMAT(/*INPUT AREA (SQ FT),LOCATION CODE & DELAY(MSEC)*
+     * FOR WINDOW*,I2,+)
G=1.4 $ G2=1./G $ G3=1.-G2 $ G4=2./G3 $ G5=G+1.
PP2=.1912
C=SQRT(G*PO*32.*144./RHOO)
TAU=2.*(V3**(1./3.))/C
DT=TAU/4.0
C
20 IF(KWALL.EQ.0)GOTO 25
PRINT 86
86 FORMAT(/*INPUT DELAY TIME (MSEC) TO INITIAL LOADING *,
+       *INTERIOR WALL*,+)
READ,DELAY
DELAY=DELAY/1000.0
25 CALL CHAIN(RCWALL2)
99 STOP
END
SUBROUTINE WINDOW (QMULT,ZLV,ZLH,ZLVW,ZLHW,AWIN,AWALL,R,ICASE)
C
C: THIS SUBROUTINE DETERMINES THE STRUCTURAL
C: MODIFICATION FACTOR FOR WALLS WITH WINDOWS
IF(ICASE.GT.4.AND.ICASE.NE.10)GOTO 320
```

```
      RWWS=ZLVW/ZLV
      RWWL=ZLHW/ZLH
      RAREA=AWIN/AWALL
      IF(R.LE.1.5)GOTO 300
      IF(RWWS.GT.0.7)GOTO 300
      IF(RWWL.LT.0.5)GOTO 300
      IF(RWWS.EQ.RWWL)GOTO 300
C
C:  CASE WHERE LV/LH >= 1.5, LVW/LV <= 0.7, AND LHW/LH >= 0.5
C:  (BUT LVW/LV NOT EQUAL TO LHW/LH)
      OMULT=-5.85461-12.6644*RAREA+4.39662*RWWS+0.84843*RWWL
+        -0.2283*R-1.07269*(ZLVW/ZLHW)**0.9+6.59542*EXP(RAREA)
      GOTO 315
C
C:  CASE WHERE ONE OR MORE OF ABOVE CONDITIONS IS NOT MET
  300 OMULT=0.62022-2.23415*RAREA**(RWWL**4)-0.79461*RWWL**2
+        -2.27663*RWWL+0.62522*RWWL/RAREA**0.3
+        +2.63043*EXP(RAREA)-0.09268*RWWS
  315 CONTINUE
      RETURN
C
C  ONE-WAY ACTION WALLS
  320 OMULT=(AWALL-ZLV*ZLHW)/(AWALL-AWIN)
      RETURN
      END
      SEGMENT RCWALL2 (INPUT,OUTPUT)
C  THIS SEGMENT CALCULATES THE RESISTANCE FUNCTION AND
C  LOADING AND SOLVES THE DYNAMIC EQUATIONS OF MOTION
C
      COMMON KWALL,KINC,LDTYPE,KRF,KRAND,TIME,I,Y(100),Q,QU,YU,YFAIL,
+      ZLV,ZLH,TW,PV,FPC,FDY,ICASE,NOBAR,AS(4),APS(4),D(4),DP(4),FDC,
+      EC,ES,R,ALP,ALP2,AREA,ZMASS,OMULT,VFAIL,ZKLM,VH1,VH2,VV1,VV2,
+      W,P3,CO,L3C,S,ZLEN,CO,PSO,PDO,PF,PEXT,PC,TC,TO,DELAY,
+      NWIN,RHOO,V3,L1,AA(8,2),NN(8),AFRONT,ASIDE,G,G2,G3,G4,PP2,DT
      COMMON /RAND/ TIMEC
      DIMENSION A(80),V(80),T(80),VV(80),VH(80),PEX(80),PIN(80),PN(80)
C
      IF(KINC.NE.1.OR.LDTYPE.EQ.5)CALL FORCE(1)
   14    IF(KRAND.NE.1)GOTO 35
         CALL FORCE(4)
         CALL RANDOM(1)
   34    CALL RANDOM(2)
   35    CALL RESIST(3)
C
C: MINIMUM, MAXIMUM, AND STARTING VALUES ARE DETERMINED FOR CASES
C: WHERE THE LOAD CAUSING INCIPIENT COLLAPSE IS TO BE FOUND
   13    IF(KINC.EQ.0)GOTO 23
          PF=QU
          PFMAX=0
          PFMIN=PF/2.0
         GOTO 20
   16     PF=(PFMIN+PFMAX)/2.0
   20    CALL FORCE(2)
   23    IF(KRF.EQ.0)GOTO 24
         CALL FILL(PINT,2)
C
C: INITIALIZE VALUES FOR BETA METHOD (BETA = 1/6) AND COMPUTE VALU
C: FOR FIRST TIME INTERVAL ASSUMING WALL INITIALLY AT REST
   24     I=1
          TIME=0
         T(1)=0$ V(1)=0$ Y(1)=0
          DELTA=0.001
         IF(KWALL.EQ.0)GOTO 29
   27    IF(TIME.GE.(DELAY-0.00001))GOTO 28
         TIME=TIME+DELTA
         CALL FILL(PINT,3)
         GOTO 27
   28    PIN(1)=PINT
         TPNET=AREA*PINT
         T(1)=TIME
         GOTO 30
   29    CALL FORCE(3)
         TPNET=AREA*PEXT
          PN(1)=PEXT
```

PROGRAM RCWALL (CONTINUED)

```
30    CALL RESIST(2)
A(I)=TPNET/(ZMASS*ZKLM)
VV(I)=VV1*TPNET
VH(I)=VH1*TPNET
C
C: PROCEDURE FOR ALL SUBSEQUENT TIME INTERVALS
1       I=I+1
IF(I.LT.81)GOTO 11
        PRINT 98,TIME
98 FORMAT(/*I=81:  TIME =*,F6.3,*  FAILURE ASSUMED TO NOT OCCUR*)
        GOTO 6
11    TIME=TIME+DELTA
        T(I)=TIME
        A(I)=A(I-1)
      CALL FORCE(3)
        PEX(I)=PEXT
      IF(KWALL.EQ.1)GOTO 10
      IF(KRF.EQ.0)GOTO 3
      CALL FILL(PINT,3)
        PIN(I)=PINT
      TPNET=AREA*(PEXT-PINT)
        GOTO 2
3       TPNET=AREA*PEXT
      GOTO 2
10    CALL FILL(PINT,3)
      PIN(I)=PINT
      TPNET=AREA*PINT
2     PN(I)=TPNET/AREA
      DO 8 II=1,10
        Y(I)=Y(I-1)+DELTA*V(I-1)+DELTA*DELTA*(A(I-1)/3.+A(I)/6.)
        CALL RESIST(2)
        QT=Q*AREA
4 ANEW=(TPNET-QT)/(ZMASS*ZKLM)
        ADELTA=ANEW-A(I)
        A(I)=ANEW
IF(ANEW.LT.0.0)PRINT,*1945*,TIME,TPNET,QT,ZMASS,ZKLM,Y(I),A(I-1)
      IF(ABS(ADELTA/(ANEW+1E-10)).LT.0.01)GOTO 9
8       CONTINUE
        A(I)=ANEW-ADELTA/2.0
PRINT 80,TIME,PF,A(I),Y(I)
9       CONTINUE
        Y(I)=Y(I-1)+DELTA*V(I-1)+DELTA*DELTA*(A(I-1)/3.+A(I)/6.)
        V(I)=V(I-1)+DELTA*(A(I)+A(I-1))/2.0
VV(I)=VV1*TPNET+VV2*QT
VH(I)=VH1*TPNET+VH2*QT
C
C: CHECK FOR MAXIMUM DEFLECTION OR FAILURE OF WALL
C:   IF MAXIMUM DEFLECTION REACHED, WALL DID NOT FAIL
      IF(Y(I).LE.Y(I-1).AND.PN(I).LE.PN(I-1))GOTO 6
      IF(Y(I).LT.0)GOTO 6
      IF(TIME-DELAY.GE.0.010)DELTA=0.002
      IF(TIME-DELAY.GE.0.020)DELTA=0.005
      IF(TIME-DELAY.GE.0.100)DELTA=0.010
      IF(TIME-DELAY.GE.0.500)DELTA=0.050
C   IF FAILURE DEFLECTION REACHED, WALL FAILED
      IF(Y(I).GE.YFAIL)GOTO 7
        GOTO 1
C
C: INTERVAL HALVING PROCEDURE TO DETERMINE LOAD CAUSING INCIPIENT
C: COLLAPSE FOR CASES WHERE DESIRED
C:   WALL DID NOT FAIL - SET PFMIN TO PF
6     CONTINUE
      IF(KINC.EQ.0)GOTO 18
36    PFMIN=PF
IF(PFMAX.GT.0)GOTO 16
PF=2.0*PF
        GOTO 20
C:   WALL FAILED - SET PFMAX TO PF
7     CONTINUE
      TIMEC=TIME
      IF(KINC.EQ.0)GOTO 18
37    PFMAX=PF
C:   CHECK TO SEE IF LOAD RANGE IS WITHIN DESIRED ACCURACY
17      IF((PFMAX-PFMIN)/PFMIN.GT.0.01)GOTO 16
```

PROGRAM RCWALL (CONTINUED)

```
      IF(KRAND.NE.1)GOTO 18
      CALL RANDOM(3)
      GOTO 34
C
C: OUTPUT DATA INCLUDES THE MAXIMUM DEFLECTION AND TIME OF
C: OCCURANCE FOR A NON-FAILING WALL OR THE TIME AND VELOCITY
C: AT COLLAPSE FOR A FAILING WALL.  OPTIONAL OUTPUT IS THE
C: ENTIRE BEHAVIOR TIME-HISTORY OF THE WALL.
C
C: OUTPUT LOAD DATA
 18    CALL FORCE(4)
C
C: OUTPUT FINAL RESULTS
 IF(Y(I).LT.YFAIL)PRINT 70,Y(I),T(I)
 IF(Y(I).GE.YFAIL)PRINT 71,T(I),V(I)
C
C: CHECK TO SEE IF ENTIRE TIME-HISTORY OF WALL IS DESIRED
 PRINT 72
 READ,M
       IF(M.EQ.0)GOTO 25
      IF(KWALL.EQ.1)GOTO 32
      IF(KRF.EQ.0)GOTO 26
 PRINT 75,(T(J),PEX(J),PIN(J),PN(J),Y(J),VV(J),VH(J),J=1,I)
       GOTO 25
 26 PRINT 76,(T(J),PEX(J),A(J),V(J),Y(J),VV(J),VH(J),J=1,I)
      GOTO 25
 32 PRINT 76,(T(J),PIN(J),A(J),V(J),Y(J),VV(J),VH(J),J=1,I)
 25 PRINT 77
 STOP
C
 70 FORMAT(/*WALL DID NOT FAIL - MAX. DEFLECTION OF*F6.2
+     * IN. REACHED AT*F7.3,* SEC*)
 71 FORMAT(/*WALL FAILED AT*,F7.3,* SEC (FINAL VELOCITY =*
+    F7.2* IN./SEC)*)
 72 FORMAT(/*IS TIME HISTORY OF WALL DESIRED (YES=1, NO=0)*,+)
 75 FORMAT(15X*PRESSURE ON WALL*/*  TIME   EXTERIOR  *
+ *INTERIOR    NET      DISPLACEMENT     VV        VH*/
+    (F6.3,3F10.3,F12.4,F11.0,F8.0))
 76 FORMAT(/*  TIME  PRESSURE  ACCELERATION  VELOCITY  *
+    *DISPLACEMENT     VV       VH*/
+    (F6.3,F9.3,F12.1,F12.2,F12.4,F11.0,F8.0))
 77    FORMAT(///,7(*-----------*))
 80 FORMAT(/*ACCELERATION NOT CONVERGING AT TIME =*,F6.3,
+            * SEC (PF =*,F7.3,* PSI)*/*      A(I) SET EQUAL TO*,
+            F8.1,* (AVG OF LAST 2 ITERATIONS)*/*      Y(I) =*,
+            F6.4,* IN.*)
 999   STOP
      END
 SUBROUTINE FORCE(IENTRY)
C  THIS SUBROUTINE INPUTS THE LOAD PARAMETERS AND DETERMINES
C  THE LOAD AT A GIVEN TIME FOR THE FOLLOWING LOAD TYPES:
C     1. IDEALIZED BLAST LOAD (FRONT OR SIDE FACE)
 COMMON KWALL,KINC,LDTYPE,KRF,KROND,TIME,I,Y(100,2),QU,YU,YFAIL,
+  ZLV,ZLH,TW,PV,FPC,FDY,ICASE,NOBAR,AS(4),APS(4),D(4),DP(4),FDC,
+  EC,ES,R,ALF,ALF2,AREA,ZMASS,QMULT,VFAIL,ZKLM,VH1,VH2,VV1,VV2,
+  W,PO,CO,LOC,S,ZLEN,CD,PSO,PDO,PR,P,PC,TC,TO,DELAY,
+  NWIN,RHOO,V3,L1,AA(8,2),VN(8),AFRONT,ASIDE,G,G2,G3,G4,PP2,DT
 DIMENSION TT(10),PP(10)
C
 IF(LDTYPE.EQ.5)GOTO 500
C
 GOTO(215,200,300,4),IENTRY
C
C  CALCULATE LOAD PROPERTIES FOR GIVEN PEAK PRESSURE
 200 GOTO(205,210),LOC
 205 PSO=(PR-14.0*PO+SQRT(196.0*PO*PO+196.0*PO*PR+PR*PR))/16.0
 GOTO 215
 210 PSO=PR
 215 PDO=2.5*PSO*PSO/(7.0*PO+PSO)
 U=CO*SQRT(1.0+(6.0*PSO)/(7.0*PO))
 TO=W**0.3333/(2.2399+0.1596*PSO)
 GOTO(220,225),LOC
 220 TC=3.0*S/U
 PC=PSO*(1-TC/TO)*EXP(-TC/TO)+PDO*(1-TC/TO)**2*EXP(-2*TC/TO)
```

PROGRAM RCWALL (CONTINUED)

```
11130 CO=1.0
11140 RETURN
11150 225 TA=ZLEN/I
11160 TA2=TA/2.0
11170 TA2TO=TA2/TO
11180 PA=PSO*(1-TA2TO)*EXP(-TA2TO)+CO*PDO*(1-TA2TO)**2*EXP(-2*TA2TO)
11190 RETURN
12000C
12010C  CALCULATE LOAD
12030 300 GOTO(305,310),LOC
12040 305 TTO=TIME/TO
12050 IF(TIME.GT.TC)GOTO 320
12060 P=PC+(TC-TIME)*(PR-PC)/TC
12070 RETURN
12080 310 TTO=(TIME-TA2)/TO
12090 IF(TIME.GT.TA)GOTO 320
12100 P=PA*TIME/TA
12110 RETURN
12120 320 IF(TTO.GE.1.0)GOTO 330
12130 P=PSO*(1-TTO)*EXP(-TTO)+CO*PDO*(1-TTO)**2*EXP(-2*TTO)
12150 RETURN
12160 330 P=0
12170 RETURN
13000C
13010C  PRINT LOAD DATA
13020 4 IF(LOC.EQ.1)GOTO 400
13030 PRINT 640,LOTYPE
13040 GOTO 410
13050 400 PRINT 645,LOTYPE
13060 410 CONTINUE
13070 415 GOTO(420,425),LOC
13080 420 PRINT 650
13090 GOTO 430
13100 425 PRINT 655
13110 430 PRINT 660,W,R1,C1
13120 IF(KRAND.NE.0)RETURN
13130 GOTO(435,440),LOC
13140 435 PRINT 665,S,TC,PR
13150 GOTO 445
13160 440 PRINT 670,ZLEN,TA,PA
13170 445 PRINT 675,TO,CO,PSO,PDO
13180 RETURN
13500C
13510C  LOAD TYPE 5 -- ARBITRARY LOAD SHAPE
13520 500 GOTO(510,520,530,540),IENTRY
13530C
13540C  INPUT LOAD DATA
13550 510 PRINT 680
13560 READ,NPOINT,(TT(I),PP(I),I=1,NPOINT)
13570 FACTOR=1.0
13580 IF(ING.EQ.0)GOTO 518
13590 PMAX=PP(1)
13600 DO 515 I=2,NPOINT
13610 515 IF(PP(I).GT.PMAX)PMAX=PP(I)
13620 518 PX=PP(2)-PP(1)
13630 TX=TT(2)-TT(1)
13640 II=1
13650 RETURN
13660C
13670C  CALCULATE MAXIMUM LOAD
13680 520 FACTOR=PR/PMAX
13690 GOTO 518
13700 RETURN
13710C
13720C  CALCULATE LOAD
13730 530 IF(TIME.LE.TT(II+1))GOTO 535
13740 II=II+1
13750 PX=PP(II+1)-PP(II)
13760 TX=TT(II+1)-TT(II)
13765 IF(TX.EQ.0)TX=1E-10
13770 GOTO 530
13780 535 P=FACTOR*(PP(II)+(TIME-TT(II))*PX/TX)
13790 RETURN
13800C
```

PROGRAM RCWALL (CONTINUED)

```
13810C  PRINT LØAD DATA
13815 540 IF(KINC.EQ.1)PRINT 640,LDTYPE
13820 IF(KINC.EQ.0)PRINT 645,LDTYPE
13825 PRINT 690
13830 DØ 545 I=1,NPØINT
13840 P=FACTØR*PP(I)
13850 545 PRINT 695,TT(I),P
13860 RETURN
14000C
14010 600 FØRMAT(/*INPUT W,PØ,CØ,LØC,S*,/)
14020 605 FØRMAT(/*INPUT L,CD*,/)
14060 630 FØRMAT(/*INPUT PSØ*,/)
14070 640 FØRMAT(/*LØAD CAUSING INCIPIENT FAILURE IS AS FØLLØWS:*,
14071*      /,5X,*LØAD TYPE NUMBER*,I2)
14080 645 FØRMAT(/*PRØPERTIES ØF LØAD ACTING ØN WALL ARE AS FØLLØWS:*,
14081*      /,5X,*LØAD TYPE NUMBER*,I2)
14090 650 FØRMAT(8X,*(FRØNT FACE)*)
14100 655 FØRMAT(8X,*(SIDE FACE)*)
14110 660 FØRMAT(10X,*W =*,F8.1,* KT   PØ =*,F6.2,* PSI     CØ =*,
14111*      F7.1,* FPS*)
14120 665 FØRMAT(10X,*S =*,F6.1,* FT     TC =*,F6.3,* SEC     PR =*,
14121*      F7.3,* PSI*)
14130 670 FØRMAT(10X,*L =*,F6.1,* FT     TA =*,F6.3,* SEC     PA =*,
14131*      F7.3,* PSI*)
14140 675 FØRMAT(10X,*U =*,F7.1,* FPS   TO =*,F6.3,* SEC     CD =*,
14141*      F5.1,/,8X,*PSØ =*,F7.3,* PSI  PDØ =*,F7.3,* PSI*)
14150 680 FØRMAT(/*INPUT NUMBER ØF LØAD PØINTS AND THE TIME AND *,
14151*      *PRESSURE AT EACH PØINT*)
14160 690 FØRMAT(/10X,*TIME        PRESSURE*)
14170 695 FØRMAT(F15.3,F12.2)
15000 END
20000 SUBRØUTINE FILL(P3,IENTRY)
20010C: CØMPUTES AVERAGE AIR PRESSURE IN RØØM DUE TØ BLAST WAVE
20020C: INCIDENT HEAD-ØN UPØN FRØNT WALL.
20030C
20050 CØMMØN KWALL,KINC,LDTYPE,KRF,KRAND,TIME,II,Y(100),Q,QU,YU,YFAIL,
20052*   ZLV,ZLM,TW,PV,FPC,FDY,ICASE,NØBAR,AS(4),APS(4),D(4),DP(4),FDC,
20054*   ES,ES,R,ALP,ALP2,AREA,ZMASS,QMULT,VFAIL,ZKLM,VM1,VM2,VV1,VV2,
20056*   W,PØ,CØ,LØC,S,ZLEN,CD,PSØ,PDØ,PR,PEXT,PC,TC,TO,DELAY,
20058*   NWIN,RHØØ,V3,L1,AA(8,2),NN(8),AFRØNT,ASIDE,G,G2,G3,G4,PP2,DT
20090 LØGICAL L1,L2,L3
20095C
20100 GØTØ(10,13,11),IENTRY
20110 10 RETURN
20310C
20320 13 P3Ø=P3
20330 TT=0.$ TØ=0.
20340 RHØ3Ø=RHØØ
20350 L2=.FALSE. $ L3=.FALSE.
20360 RETURN
20370C
20380 11 IF(L1)GØTØ 52
20385 IF(L2.A.L3)GØTØ 9
20390 52 DDT=(TIME-TØ)*0.5
20395 ISTØP=2
20400 53 IF(DDT.LT.DT)GØTØ 51
20410 50 DDT=0.5*DDT
20415 ISTØP=2*ISTØP
20420 GØ TØ 53
20430 51 CØNTINUE
20440 DØ 99 I=1,ISTØP
20450 TT=TØ+I*DDT
20460 IF(TT.GT.TO)GØ TØ 99
20470 DM=0. $ WW=0. $ VW=0
20480 DØ 500 K=1,NWIN
20490 M=NN(K) $ DLY=AA(K,2)+0.000001
20500 IF(DLY.GE.TT)GØ TØ 500
20510 GØTØ(15,16,16),M
20520 15 CDF=1.0
20530 IF(TT-TC)20,20,21
20540 20  P11=(TC-TT)*(PR-PC)/TC+PC
20550 P11=P11+PØ
20560 GØ TØ 30
20570 16 CDF=-0.4
```

PROGRAM RCWALL (CONTINUED)

```
20600 21   R=TT/TO $ RR=1.-R
20610 PD=PD3*RR*RR*EXP(-2.*R)
20620 PS=PS3*RR*EXP(-R)
20630 P11=PS+CDF*PD
20640 P11=P11+P1
20650 30  RH31=RH31*((P11/P1)**G2)
20660 IF(P11-P33)36,36,37
20670       ISIGN=-1
20680 L2=.TRUE.
20770 303  P2=P11
20780 RH32=((P2/P33)**G2)*RH33)
20790 X=P33/RH33
20800 GO TO 38
20810 37  ISIGN=+1
20820 306 P2=PP2*P11
20830 RH32=((P2/P11)**G2)*RH31
20840 X=P11/RH31
20850 38   U22=G4*(X-P2/RH32)*32.*144.
20860 IF(U22)40,39,39
20870 40   PRINT,*U22 NEGATIVE*,U22
20880 STOP
20890 39   U2=SQRT(U22)*ISIGN
20900 DDM=U2*RH32*AA(K,1)*DDT
20910 DM=DM+DDM
20920 ww=w+P11*DDM/(G3*RH31)
20925C
20930 500 CONTINUE
20940 P33=P33+(G-1.)*WW/V3
20950 RH333=RH333+DM/V3
20960 99   CONTINUE
20970 TO=TT
20980 P3=P33-P1
20982 IF(TIME.GE.TC)L3=.TRUE.
20983 RETURN
20984 9 R=TIME/TO $ RR=1.0-R
20985 PD=PD3*RR*RR*EXP(-2.0*R)
20986 PS=PS3*RR*EXP(-R)
20987 P3=PS+PD*(AFRONT-0.4*ASIDE)
20990 999 RETURN
21020 END
30000 SUBROUTINE RESIST (IENTRY)
30010C: THIS SUBROUTINE INPUTS THE REQUIRED WALL DATAS DETERMINES THE
30020C: RESISTANCE FUNCTION, TRANSFORMATION FACTORS, AND REACTION
30030C: COEFFICIENTSS AND SUPPLIES THE REACTION VALUES FOR SPECIFIC
30040C: DEFLECTIONS REQUIRED IN THE DYNAMIC ANALYSIS
30045C
30050 COMMON KWALL,KINC,LDTYPE,KRF,KRAND,TIME,I,Y(100),D,DU,YU,YFAIL,
30052+   ZLV,ZLH,TW,PV,FPC,FDY,ICASE,NOBAR,AS(4),APS(4),D(4),DP(4),FDC,
30054+   EC,ES,R,ALP,ALP2,AREA,ZMASS,DMULT,VFAIL,ZKLM,VH1,VH2,VV1,VV2,
30056+   W,P3,C3,LOC,S,ZLEN,CD,PS3,PD3,PR,PEXT,PC,TC,TO,DELAY,
30058+   NWIN,RH33,V3,L1,AA(3,2),NN(8),AFRONT,ASIDE,G,G2,G3,G4,PP2,DT
30100 REAL N,IC,IG,MM,KK1,KK2,KK3,MU(4),ICR(4)
30135C
30140 GOTO(4,500,45),IENTRY
30150 4 RETURN
30790C
30800C: ****************************************
30810C: * ENTRY 2: DETERMINE WALL PROPERTIES    *
30820C: *            DEPENDENT ON FDC, FDY, AND D *
30830C: ****************************************
30840C
30850 45 N=ES/EC
30900 FR=8.0*SQRT(FDC)
30916 IG=TW**3/12+(N-1)*(AS(1)*(D(1)-TW/2)**2+APS(1)*(TW/2-DP(1))**2)
30917 CALL COEF(ICASE,R,ASS,ASS,DF,RF,IG,ZLV,ZLH,PV,NK,CF,EC,1)
30920 MM=2.0*IG*(FR+PV/TW)/TW
30925 CALL MOMENT(FDC,FDY,ES,N,PV,1.0,AS,APS,D,DP,MU,ICR,IC)
31470 GMU=MU(2)/MU(1)
31480C
31490C: DETERMINE POSITION OF YIELD LINES AND ULTIMATE RESISTANCE
31500C: COEFFICIENTS FOR TWO-WAY WALLS
31510 IF(ICASE.GT.4)GOTO 106
31520 Z11=MU(4)/MU(2)
31530 Z13=MU(3)/MU(1)
```

PROGRAM RCWALL (CONTINUED)

```
GAMMA12=2.0*SQRT(1.0+ZI1)
GAMMA34=2.0*SQRT(1.0+ZI3)
GRAT=GAMMA12/GAMMA34
B=SQRT(1+ZI1)*(GMU*ALP2/GAMMA34)*(SQRT(GRAT**2+3/
+  (GMU*ALP2))-GRAT)
C: IF BETA IS GREATER THAN 0.5 ASSUMPTIØN ØF CRACK PATTERN A
C: NØT VALID AND CRACK PATTERN B IS ASSUMED TØ ØCCUR
IF(B.LE.0.5)GØTØ 105
C
C: CRACK PATTERN B
KRAK=1
B=SQRT(1.0+ZI3)*(SQRT(1.0/GRAT**2+GMU*ALP2*3.0)-1.0/GRAT)
+  /(GMU*ALP2*GAMMA12)
QUTERM=6.0*GAMMA12**2*ALP*GMU/(SQRT(3+3/(GMU*ALP2*GRAT**2))
+  -1.0/(SQRT(GMU)*ALP*GRAT))**2
GØTØ 108
C
C: CRACK PATTERN A
105 CØNTINUE
KRAK=0
QUTERM=6.0*GAMMA34**2/(ALP*(SQRT(3+GMU*ALP2*GRAT**2)
+  -ALP*GRAT*SQRT(GMU))**2)
GØTØ 106
C
C: DETERMINE MØMENT AND DEFLECTIØN CØEFFICIENTS
C: FØR CRACKED PØRTIØN ØF WALL BEHAVIØR
106 B=0
108 IF(PV.EQ.0)GØTØ 180
CALL CØEF(ICASE,R,ASSC,BSSC,AFC,BFC,IC,ZLV,ZLH,PV,NX,CF,EC,2)
GØTØ(195,195,195,195,112,115,120),ICASE
112 QUTERM=1.0/(BSSC*ZLV)
GØTØ 195
115 QUTERM=(1.0/BSSC+(ZLV*ZLV*PV/(EC*IC))*MU(3)/(MU(1)*(1.0
+  -CØS(0.5*ZLV*SQRT(PV/(EC*IC))))))/ZLV
CF=BFC
GØTØ 195
120 QUTERM=(1.0+0.5*MU(3)/(MU(1)*CØS(0.5*ZLV*SQRT
+  (PV/(EC*IC)))))/(BSSC*ZLV)
CF=BFC
GØTØ 195
180 ASSC=ASS$ AFC=AF
GØTØ(195,195,195,195,182,185,190),ICASE
182 QUTERM=1.0/(BSS*ZLV)
GØTØ 195
185 QUTERM=(MU(3)/MU(1)+1.0)/(BSS*ZLV)
GØTØ 195
190 QUTERM=(0.5*MU(3)/MU(1)+1.0)/(BSS*ZLV)
195 GØTØ(200,210,210,210,200,210,210),ICASE
C
C: ***************************************************************
C: * DETERMINE RESISTANCE CURVE FØR WALL                          *
C: * (Q IS IN UNITS ØF PSI, KK IN LB/CU.IN., AND Y IN INCHES)     *
C: ***************************************************************
C
C: CASES 1 AND 5
200 Q1=MM/(BSS*ZLV*ZLV)
KK1=EC*IG/(ASS*ZLV**4)
Y1=Q1/KK1
KK2=EC*IC/(ASSC*ZLV**4)
IF(ICASE.EQ.5)GØTØ 205
QU=QUTERM*MU(1)/(ZLV*ZLH+0.5*QUTERM*PV/KK2)
GØTØ 208
205 QU=QUTERM*MU(1)/ZLV
208 YU=QU/KK2
GØTØ 280
C
C: CASES 2, 3, 4, 6, & 7
210 Q1=MM/(BF*ZLV*ZLV)
KK1=EC*IG/(AF*ZLV**4)
Y1=Q1/KK1
Q2=MU(NX)/(CF*ZLV*ZLV)
KK2=EC*IC/(AFC*ZLV**4)
Y2=Q2/KK2
KK3=EC*IC/(ASSC*ZLV**4)
```

PROGRAM RCWALL (CONTINUED)

```
IF(ICASE.GT.4)GOTO 215
QU=QUTERM*(MU(1)-PV*(Y2-Q2/KK3)/2)/(ZLV*ZLH+0.5*QUTERM*PV/KK3)
GOTO 220
215 QU=QUTERM*MU(1)/ZLV
220 YU=Y2+(QU-Q2)/KK3
230 IF(PV.NE.0)YFV=MU(1)/(PV*(1.0-B))
C
C: CHECK FOR TYPE OF FAILURE - LIGHTLY REINFORCED OR CONVENTIONAL
IF(MU(1).LT.1.5*MM)GOTO 288
C
C: CONVENTIONAL TYPE FAILURE
YFAIL=YU*0.1/(AS(1)/D(1))
C: DUCTILITY FACTOR MUST BE <= 30
IF(YFAIL.GT.30.0*YU)YFAIL=30.0*YU
GOTO 285
C
C: LIGHTLY REINFORCED TYPE OF FAILURE
C:   THE FOLLOWING EXPRESSION IS BASED ON A STEEL ELONGATION OF 20%
288 UCOEF=30.
UPU=UCOEF*SQRT(FDC)
ABAR=3.14159*(NOBAR/16.)**2
290 YFAIL=SQRT((0.2*ABAR*FDY/UPU+ZLV/2.)**2-(ZLV/2.)**2)
285 IF(PV.EQ.0)GOTO 295
C:
C: IF FAILURE DEFLECTION DUE TO INSTABILITY IS LESS THAN VALUE
C: BASED ON REINFORCEMENT, SUBSTITUTE THIS VALUE FOR YFAIL
IF(YFAIL.GT.YFV)YFAIL=YFV
QFAIL=QU*(YFV-YFAIL)/(YFV-YU)
GOTO 298
295 QFAIL=QU
298 CONTINUE
C
C: MODIFY RESISTANCE VALUES BY WINDOW MODIFICATION FACTOR
Q1=Q1*QMULT
Q2=Q2*QMULT
QU=QU*QMULT
QFAIL=QFAIL*QMULT
KK1=KK1*QMULT$ KK2=KK2*QMULT$ KK3=KK3*QMULT
C
C: OUTPUT LOAD-DEFLECTION CURVE
IF(KRAND.EQ.1)GOTO 335
PRINT 650
IF(ICASE.EQ.1.OR.ICASE.EQ.5)GOTO 320
PRINT 660,Q1,Y1,Q2,Y2
GOTO 330
320 PRINT 660,Q1,Y1
330 PRINT 660,QU,YU,QFAIL,YFAIL
335 CONTINUE
C
CALL TRANS (9,ZLV,ZLH,ICASE,KRAK,ZKLMSE,ZKLMFE,ZKLMP,VH1S,VH2S,
+   VV1S,VV2S,VH1F,VH2F,VV1F,VV2F,VH1P,VH2P,VV1P,VV2P)
RETURN
C
C: *********************************************************
C: * ENTRY 3: DETERMINE THE RESISTANCE (PER UNIT AREA) *
C: *          OF THE WALL AS A FUNCTION OF Y(I)        *
C: *********************************************************
C
500 IF(Y(I).GE.YFAIL)GOTO 560
IF(Y(I).GT.YU)GOTO 540
GOTO(501,520,520,520,501,520,520),ICASE
501 CONTINUE
C
C: ELASTIC RANGE -- CASES 1 AND 5
ZKLM=ZKLMSE
VH1=VH1S $ VH2=VH2S
VV1=VV1S $ VV2=VV2S
IF(Y(I).GT.Y1)GOTO 510
C
C: UNCRACKED PORTION -- ALL CASES
505 Q=Y(I)*KK1
RETURN
C
C: CRACKED PORTION -- CASES 1 AND 5
```

PROGRAM RCWALL (CONTINUED)

```
510 Q=Q1+(Y(I)-Y1)*(QU-Q1)/(YU-Y1)
RETURN
C
520 IF(Y(I).GT.Y2)GOTO 530
C
C: ELASTIC RANGE -- CASES 2,3,4,6,7
ZKLM=ZKLMFE
VH1=VH1F $ VH2=VH2F
VV1=VV1F $ VV2=VV2F
IF(Y(I).LT.Y1)GOTO 505
C: CRACKED PORTION -- CASES 2,3,4,6,7
Q=Q1+(Y(I)-Y1)*(Q2-Q1)/(Y2-Y1)
RETURN
C
C: ELASTO-PLASTIC RANGE -- CASES 2,3,4,6,7
530 ZKLM=ZKLMSE
VH1=VH1S $ VH2=VH2S
VV1=VV1S $ VV2=VV2S
Q=Q2+KK3*(Y(I)-Y2)
RETURN
C
C: PLASTIC RANGE -- ALL CASES
540 ZKLM=ZKLMP
VH1=VH1P $ VH2=VH2P
VV1=VV1P $ VV2=VV2P
IF(PV.GT.0)GOTO 550
C: NO INPLANE FORCES
Q=QU
RETURN
C: WITH INPLANE FORCES
550 Q=QU*(YFV-Y(I))/(YFV-YU)
RETURN
C
C: WALL COLLAPSED - NO RESISTANCE (TO AVOID NUMERICAL DIFFICULTIEES
C: FOR CERTAIN CASES SET RESISTANCE EQUAL TO VERY SMALL VALUE)
560 Q=1E-10
RETURN
C
650 FORMAT(//*LOAD-DEFLECTION CURVE*,/,3X,*Q (PSI)     Y (IN.)*)
660 FORMAT(F9.2,F12.4)
END
SUBROUTINE MOMENT(FDC,FDY,ES,N,PV,B,AS,APS,D,DP,MU,ICR,IC)
C THIS SUBROUTINE DETERMINES THE ULTIMATE MOMENT CAPACITY AND
C CRACKED MOMENT OF INERTIA  FOR REQUIRED SECTIONS
REAL [illegible] K2,K3,KUD,N,IC,ICTOT,MU(4),ICR(4),AS(4),APS(4),D(4),DP(4)
C
C: DETERMINE VALUES OF CONCRETE PARAMETERS
45 K1=0.94-FDC/26E3
K2=0.50-FDC/8E4
K3=(3900.0+0.35*FDC)/(3E3+0.82*FDC-FDC*FDC/26E3)
EPSC=0.004-FDC/65E5
C: ***************************************************
C: * DETERMINE ULTIMATE MOMENT CAPACITY AND CRACKED *
C: * MOMENT OF INERTIA FOR REQUIRED SECTIONS        *
C: ***************************************************
C
II=0$ ICTOT=0
DO 170 I=1,4
IF(AS(I).EQ.0)GOTO 170
II=II+1
C: ALL PROPERTIES ARE COMPUTED FOR A WIDTH B
TENS=AS(I)*FDY+PV
IF(APS(I).LE.0)GOTO 150
C
C: WALL HAS COMPRESSION REINFORCEMENT
C=K1*K3*FDC*B*DP(I)
TERM1=0.5*(TENS/APS(I)+ES*EPSC)
TERM2=ES*EPSC*(TENS-C)/APS(I)
C: DETERMINE LOCATION OF NEUTRAL AXIS
IF(TENS.LE.C)GOTO 140
C
C: KUD > D'
FPS=TERM1+K3*FDC/2.0-SQRT((TERM1+K3*FDC/2.0)**2
+  -(TERM2+ES*EPSC*K3*FDC))
```

PROGRAM RCWALL (CONTINUED)

```
35380C: F'S MUST BE <= FDY
35390 IF(FPS.LT.FDY)GOTO 130
35400 FPS=FDY
35410 130 TPS=APS(I)*(FPS-K3*FDC)
35420 KUD=(TENS-TPS)/(K1*K3*FDC*B)
35430 MU(I)=(TENS-TPS)*(D(I)-K2*KUD)+TPS*(D(I)-DP(I))
35440 ICR(I)=B*KUD**3/3.0+N*AS(I)*(D(I)-KUD)**2
35450+  +(N-1)*APS(I)*(KUD-DP(I))**2
35460 GOTO 152
35470C
35480C: KUD < D'
35490 140 FPS=-TERM1+SQRT(TERM1**2-TERM2)
35500C: F'S MUST BE <= FDY
35510 IF(FPS.LT.FDY)GOTO 145
35520 FPS=FDY
35530 145 TERM3=TENS+APS(I)*FPS
35540 KUD=TERM3/(K1*K3*FDC*B)
35550 MU(I)=TERM3*(D(I)-K2*KUD)-APS(I)*FPS*(D(I)-DP(I))
35560 ICR(I)=B*KUD**3/3+N*AS(I)*(D(I)-KUD)**2+N*APS(I)*(DP(I)-KUD)**2
35570 GOTO 152
35580C
35590C: WALL HAS NO COMPRESSION REINFORCEMENT
35600 150 KUD=TENS/(K1*K3*FDC*B)
35610 MU(I)=TENS*(D(I)-K2*KUD)
35620 ICR(I)=B*KUD**3/3.0+N*AS(I)*(D(I)-KUD)**2
35630C
35640 152 ICTOT=ICTOT+ICR(I)
35650 170 CONTINUE
35660C
35670C: DETERMINE AVERAGE CRACKED MOMENT OF INERTIA
35680 175 IC=ICTOT/II
35690 RETURN
35700 END
40000 SUBROUTINE COEF(ICASE,R,ASS,BSS,AF,BF,I,ZLV,ZLH,PV,NX,CF,
40010+      E,IENTRY)
40020C:  THIS SUBROUTINE DETERMINES MOMENT AND DEFLECTION COEFFICIENTS
40030C:  FOR ONE-WAY (CASES 5-7) AND TWO-WAY (CASES 1-4) WALLS
40040C
40050       REAL I,MPR,MPRSQ,NI
40060       IF(IENTRY.EQ.2)GOTO 200
40070       NX=1
40080        IF(ICASE.GT.4)GOTO 50
40090C
40100        R2=R*R
40110        R3=R*R2
40120        R4=R2*R2
40130        ASS=-.007030+.013990*R-.003456*R2+.000286*R3
40140        BSS=-.058332+.139314*R-.035609*R2+.003016*R3
40150 8      GOTO(41,20,30,40),ICASE
40160C
40170C:  CASE 2. FIXED ON FOUR SIDES
40180 20    NX=3
40190        AF=-.003430+.007327*R-.003365*R2+.0006646*R3-.00004766*R4
40200        BF=-.101150+.260875*R-.138942*R2+.034677*R3-.004016*R4
40210+   +.000170*R**5
40220       CF=-.1674+.3554*R-.1714*R2+.0286*R3
40230        GOTO 41
40240C
40250C:  CASE 3. FIXED ON SHORT SIDES, SIMPLY SUPPORTED ON LONG SIDES
40260 30     NX=4
40270        AF=.004513-.017525*R+.023095*R2-.010325*R3+.002187*R4
40280+   -.0002208*R**5 + .000008408*R**6
40290        BF=-.122149+.313445*R-.153979*R2+.036192*R3-.004015*R4
40300+   +.0001646*R**5
40310       CF=2.1958-7.7564*R+10.8376*R2-7.2495*R3+2.344*R4
40320+          -.2954*R**5
40330        GOTO 41
40340C
40350C:  CASE 4. SIMPLY SUPPORTED ON SHORT SIDES, FIXED ON LONG SIDES
40360 40    NX=3
40370        AF=-.002765+.008652*R-.005698*R2+.001829*R3-.0002559*R4
40380+   +.00001739*R**5
40390        BF=-.060320+.256515*R-.175649*R2+.05728*R3-.009227*R4
40400+    +.000569*R**5
```

PROGRAM RCWALL (CONTINUED)

```
 CF=5.8987*R-1.6669-7.9398*R2+5.3142*R3-1.7623*R4+.2313*R**5
C
41      IF(R.GT.2.0)CF=1.0/12.0
        IF(PV.EQ.0)RETURN
        ARATIØ=AF/ASS$  BRATIØ=BF/BSS
        BFØ=BF$ CFØ=CF
        GØTØ 220
C
50      IF(PV.NE.0)GØTØ 300
C:    CASE 5. ØNE-WAY SIMPLY SUPPØRTED WALL
        ASS=5.0/384.0
         BSS=0.125
         GØTØ(270,270,270,270,270,60,70),ICASE
C
C:    CASE 6. ØNE-WAY FIXED END WALL
60       AF=1.0/384.0
         BF=1.0/12.0
        CF=1.0/12.0
        NX=3
        RETURN
C
C:    CASE 7. ØNE-WAY PRØPEAPED CANTILEVER WALL
70       AF=1.0/185.0
         BF=0.125
        CF=0.125
        NX=3
        RETURN
C
200     IF(ICASE.GT.4)GØTØ 300
C:    DETERMINE ELASTIC DEFLECTIØN AND MØMENT CØEFFICIENT FØR
C:    TWØ-WAY WALL WITH INPLANE FØRCES
220     PI=3.14159165
         NU=0.3
         PE=4.0*PI*PI*E*I/(ZLV*ZLV*(1.0-NU*NU))
         BV=0
230      AV=0
         PPE=PV/PE
         TERM6=4.0*PI*PI*R*SQRT(PPE)
C
C:    SERIES SØLUTIØN USED TØ DETERMINE CØEFFICIENTS
         DØ 250 M=1,7,2
         MPR=M*PI*R
         MPRSQ=MPR**2
         GMSQ=MPRSQ+2.0*MPR*PI*SQRT(PPE)
         EMSQ=MPRSQ-2.0*MPR*PI*SQRT(PPE)
         TERM5=M*MPRSQ*(MPRSQ-4.0*PI*PI*PPE)
         CØSHGM2=0.5*(EXP(0.5*SQRT(GMSQ))+EXP(-0.5*SQRT(GMSQ)))
         IF(EMSQ.LT.0)GØTØ 240
         CØSHEM2=0.5*(EXP(0.5*SQRT(EMSQ))+EXP(-0.5*SQRT(EMSQ)))
         GØTØ 245
240      CØSHEM2=CØS(0.5*SQRT(-EMSQ))
245      AV=AV+(1.0+ MSQ/CØSHGM2-GMSQ/CØSHEM2)/(M*TERM6))
+   *(-1)**((M-1)/   /TERM5
         BV=BV+(MPRSQ*(GMSQ*(NU*EMSQ-MPRSQ)/CØSHEM2-EMSQ*(NU*GMSQ
+          -MPRSQ)/CØSHGM2)/(M*TERM6))*(-1)**((M-1)/2)/TERM5
250      CØNTINUE
C
C:    CASE 1
        AVSS=AV*(1.0-NU*NU)*R4*4.0/PI
         BVSS=BV*R2*4.0/PI
         IF(ICASE.EQ.1)GØTØ 260
C
C:    CASES 2, 3, AND 4
        AVF=AVSS*ARATIØ
        BVF=BVSS*BRATIØ
        CF=CFØ*BVF/BFØ
258     AF=AVF
         BF=BVF
260     ASS=AVSS
         BSS=BVSS
270     RETURN
C
C:    ØNE-WAY WALLS
300     EIPV=E*I/PV
```

PROGRAM RCWALL (CONTINUED)

```
      U=ZLV/SQRT(FIPV)
      U2=0.5*U
      TERM1=1.0/COS(U2)-1.0
C
C:  CASE 5. ONE-WAY SIMPLY SUPPORTED WALL
      BSS=TERM1/U**2
      ASS=(BSS-0.125)/U**2
      GOTO(270,270,270,270,270,310,320),ICASE
C
C:  CASE 6. ONE-WAY FIXED END WALL
 310  NX=3
      BF=(1.0-U2/TAN(U2))/U**2
      AF=-BF*BSS+ASS
      RETURN
C
C:  CASE 7. ONE-WAY PROPPED CANTILEVER WALL
 320 NX=3
      BF=TAN(U)*(TAN(U2)-U2)/(U*(TAN(U)-U))
      AF=(BF*(0.5*SIN(U2)/TAN(U)-COS(U2))-(SIN(U2)/TAN(U)
+        -COS(U2 -SIN(U2)/SIN(U)+0.125*U*U+1.0)/U**2)/U**2
      RETURN
 999 END
 SUBROUTINE TRANS (B,ZLV,ZLH,ICASE,KRAK,ZKLMSE,ZKLMFE,ZKLMP,VL1S,
+  VL2S,VS1S,VS2S,VL1F,VL2F,VS1F,VS2F,VL1P,VL2P,VS1P,VS2P)
C
C: THIS SUBROUTINE DETERMINES LOAD AND MASS TRANSFORMATION FACTORS
C: AND DYNAMIC REACTION COEFFICIENTS FOR TWO-WAY WALLS.
C
C: DETERMINE LOAD AND MASS TRANSFORMATION FACTORS
      B2=B*B
      B3=B*B2
      B4=B2*B2
      B5=B2*B3
      B6=B3*B3
C
C: CASES 1 & 5 -- ELASTIC RANGE
 330  ZKMSE1=20.48*B3*(1./12.-B2/7.5+B3/21+B4/14-B5/18+B6/90)
      ZKMSE2=0.5038-0.7066*B
      ZKLSE1=6.4*B2*(1./6.-B2/10.+B3/30.)
      ZKLSE2=0.64-0.8134*B
      BARS1=B*(1./12.-B2/15.+B3/42.)/(1./6.-B2/10.+B3/30.)
      BARS2=(0.127083-0.184524*B)/(0.4-0.508333*B)
      ZKMSE=ZKMSE1+ZKMSE2
      ZKLSE=ZKLSE1+ZKLSE2
      IF(KRAK.EQ.1)GOTO 335
C: CRACK PATTERN A
      CVS=0.5*B
      CVL=0.5*(1.0-B)
      XP=ZLH*B/3.0
      XBARS=BARS1*ZLH
      ZP=ZLV*(1.0-4.0*B/3.0)/(4.0*(1.0-B))
      ZBARS=BARS2*ZLV
      XBARP=0.5*B*ZLH
      ZBARP=ZLV*(1./24.-B/16.)/(1./8.-B/6.)
      GOTO 338
C: CRACK PATTERN B
 335  CVS=0.5*(1.0-B)
      CVL=0.5*B
      XP=ZLH*(1.0-4.0*B/3.0)/(4.0*(1.0-B))
      XBARS=BARS2*ZLH
      ZP=ZLV*B/3.0
      ZBARS=BARS1*ZLV
      XBARP=ZLH*(1./24.-B/16.)/(1./8.-B/6.)
      ZBARP=0.5*B*ZLV
 338    LMSE=ZKMSE/ZKLSE
      GOTO(390,340,350,360,390,340,470),ICASE
C
C: CASES 2, 3, & 4 -- ELASTIC RANGE
  350 IF(KRAK.EQ.1)GOTO 365
      GOTO 340
 360  IF(KRAK.EQ.0)GOTO 365
C: CASES 2A  2B, 3A, 4B, & 6
 340  ZKM[illegible] 512.0*B5*(1.0/30.-B/10.5+3.*B2/28.-B3/18.+B4/90.)
      ZKLFE. 32.0*B3*(1./12.-B/10.+B2/30.)
```

PROGRAM RCWALL (CONTINUED)

```
      BARF1=B*(.05-B/15.+B2/42.)/(1./12.-B/10.+B2/30.)
      GOTO(370,365,370,370,370,365),ICASE
C: CASES 2A, 2B, 3B, 4A, & 6
  365 ZKMFE2=0.4065-0.6144*B
      ZKLFE2=0.5344-0.7328*B
      BARF2=(.091667-.138095*B)/(.266667-.366667*B)
      GOTO(375,368,375,375,375,368),ICASE
C: CASES 2A & 2B
  368 ZKMFE=ZKMFE1+ZKMFE2
      ZKLFE=ZKLFE1+ZKLFE2
      GOTO 380
C:  CASES 3A & 4B
  370 ZKMFE=ZKMFE1+ZKMSE2
      ZKLFE=ZKLFE1+ZKLSE2
      GOTO 380
C: CASES 3B, 4A, & 6
  375 ZKMFE=ZKMSE1+ZKMFE2
      ZKLFE=ZKLSE1+ZKLFE2
  380 ZKLMFE=ZKMFE/ZKLFE
      GOTO 390
C: CASE 7
  470 ZKLMFE=0.78
C
C: ALL CASES -- PLASTIC RANGE
  390 ZKMP=(1.0-B)/3.0
      ZKLP=0.5-B/3.0
      ZKLMP=ZKMP/ZKLP
C
C
C: DETERMINE DYNAMIC REACTION COEFFICIENTS FOR SHORT (VS) AND
C: LONG (VL) EDGES
C
      IF(ICASE.LT.5)GOTO 395
      XBARS=1E-10$ BARF1=1E-10$ XBARP=1E-10
  395 CONTINUE
      GOTO(450,400,400,420,450,400,445),ICASE
  400 IF(KRAK.EQ.1)GOTO 410
      XBARF=BARF1*ZLH
      IF(ICASE.EQ.3)GOTO 430
  405 ZBARF=BARF2*ZLV
      GOTO 440
  410 XBARF=BARF2*ZLH
      IF(ICASE.EQ.3)GOTO 435
  415 ZBARF=BARF1*ZLV
      GOTO 440
  420 IF(KRAK.EQ.1)GOTO 425
      XBARF=BARS1*ZLH
      GOTO 405
  425 XBARF=BARS2*ZLH
      GOTO 415
  430 ZBARF=BARS2*ZLV
      GOTO 440
  435 ZBARF=BARS1*ZLV
  440 CONTINUE
C
C: CASES 2, 3, 4, & 6 -- ELASTIC RANGE
      VS1F=CVS*(1.0-XP/XBARF)
      VS2F=CVS*(XP/XBARF)
      VL1F=CVL*(1.0-ZP/ZBARF)
      VL2F=CVL*(ZP/ZBARF)
      GOTO 450
C
C: CASE 7 -- ELASTIC RANGE
  445 VS1F=0
      VL1F=0.459
      VL2F=0.165
C
C: CASE 1 & 5 -- ELASTIC RANGE
  450 VS1S=CVS*(1.0-XP/XBARS)
      VS2S=CVS*(XP/XBARS)
      VL1S=CVL*(1.0-ZP/ZBARS)
      VL2S=CVL*(ZP/ZBARS)
C
C: ALL CASES -- PLASTIC RANGE
```

PROGRAM RCWALL (CONTINUED)

```
 460  VS1P=CVS*(1.0-XP/XBARP)
      VS2P=CVS*(XP/XBARP)
      VL1P=CVL*(1.0-ZP/ZBARP)
      VL2P=CVL*(ZP/ZBARP)
      RETURN
      END
      SUBROUTINE RANDOM (IENTRY)
C THIS SUBROUTINE INPUTS MEAN AND STANDARD DEVIATIONS FOR RANDOM
C VARIABLES;  GENERATES RANDOM VALUES;  AND CONTROLS REQUIRED
C NUMBER OF CASES TO BE RUN;  AND OUTPUTS FINAL RESULTS AND SUMMARY
C
 COMMON KWALL,KINC,LDTYPE,KRF,KRAND,TIME,I,Y(100),Q,QU,YU,YFAIL,
+  ZLV,ZLH,TW,PV,FPC,FDY,ICASE,NOBAR,AS(4),APS(4),D(4),DP(4),FDC,
+  EC,ES,R,ALP,ALP2,AREA,ZMASS,QULT,VFAIL,ZKLM,VH1,VH2,VV1,VV2,
+  W,PO,CO,LOC,S,ZLEN,CD,PSO,PDO,PR,PEXT,PC,TC,TO,DELAY,
+  NWIN,RHOO,V3,L1,AA(8,2),NN(8),AFRONT,ASIDE,G,G2,G3,G4,PP2,DT
      COMMON /RAND/ TIMEC
      DIMENSION CHI25(7),CHI975(7),TDIST(7)
C
C VALUES FOR 97.5%  (F=19,24,29,34,39,44,49)
      DATA CHI25/.4638,.5167,.5533,.5825,.6065,.6267,.6440/
      DATA CHI975/1.7295,1.6402,1.5766,1.5284,1.4903,1.4591,1.4331/
      DATA TDIST/2.093,2.064,2.045,2.032,2.022,2.014,2.010/
C
      GOTO(5,50,70),IENTRY
    5 XDUMMY=XNORM1(-1.0,0.0,1.0)
C INITIALIZE RANDOM NUMBER GENERATOR
      PRINT,/,*INPUT NRAND*,
      READ,NRAND
      DO 47 I=1,NRAND
      XDUMMY=XNORM1(0.0,0.0,1.0)
   47 CONTINUE
      INDEX=0$  SPSO=0$  SSPSO=0
      ICHECK=20
C
C  INPUT MEAN AND STANDARD DEVIATION FOR RANDOM VARIABLES
      PRINT 87
      READ,SMEAN,SSD
C  REINFORCED CONCRETE WALLS
  30  PRINT 36
      READ,FDYMEAN,FDYSD
      PRINT 96
      RETURN
C
C  GENERATE RANDOM VALUES
  50  FDY=XNORM1(0.0,FDYMEAN,FDYSD)
      IF(FDY.LE.0)GOTO 50
      IF(SMEAN.EQ.0)GOTO 65
  60  S=XNORM1(0.0,SMEAN,SSD)
      IF(S.LE.0)GOTO 60
  65  INDEX=INDEX+1
      RETURN
C SUM VALUES OF PSO AND PSO**2 FOR USE IN STATISTICAL ANALYSIS
  70  SPSO=SPSO+PSO
      SSPSO=SSPSO+PSO*PSO
C
C OUTPUT FINAL RESULTS
  76  PRINT 92,FDY,S,PSO,TIMEC
  80  IF(INDEX.LT.ICHECK)RETURN
C
C DETERMINE MEAN, STANDARD DEVIATION, AND STANDARD ERROR FOR PSO
      ZNO=INDEX
      ZMEAN=SPSO/ZNO
      SD=SQRT((SSPSO-ZNO*ZMEAN*ZMEAN)/ZNO)
      STDERR=SD/(SQRT(ZNO-1))
C CHECK IF MAXIMUM OF 50 PSO SAMPLES OBTAINED
      IF(INDEX.EQ.50)GOTO 62
C CHECK IF 95% CONFIDENCE INTERVAL FOR MEAN PSO VALUE IS
      IF(STDERR*TDIST((INDEX-15)/5)/ZMEAN.GT.0.10)GOTO 61
C
C CONFIDENCE INTERVAL IS WITHIN 10% -- DETERMINE UPPER LIMIT OF
C 95% CONFIDENCE INTERVAL FOR STANDARD DEVIATION
C PROBABILITY VALUE AND ITS 95% CONFIDENCE INTERVAL UPPER LIMIT
   62 SDU=SD/(SQRT(CHI25((INDEX-15)/5)))
```

PROGRAM RCWALL (CONCLUDED)

```
C CHECK IF MAXIMUM OF 50 PSI SAMPLES OBTAINED
      IF(INDEX.EQ.50)GOTO 53
C CHECK IF UPPER VALUE OF 95% CONFIDENCE INTERVAL FOR STANDARD
C DEVIATION IS WITHIN 0.10*MEAN OF THE STANDARD DEVIATION
      IF(((SDU-SD)/ZMEAN).GT.0.10)GOTO 61
C
C 95% CONFIDENCE INTERVAL IS WITHIN 10% FOR BOTH MEAN AND 90%
C PROBABILITY VALUE -- THEREFORE SUFFICIENT SAMPLES OBTAINED
C DETERMINE 95% CONFIDENCE INTERVALS FOR MEAN, STANDARD DEVIATION
,
C AND 10% AND 90% PROBABILITY VALUES
   53 ZMEANL=ZMEAN-STDERR*TDIST((INDEX-15)/5)
      ZMEANU=ZMEAN+STDERR*TDIST((INDEX-15)/5)
      SDL=SD/(SQRT(CHI975((INDEX-15)/5)))
      P10=ZMEAN-1.282*SD
      P10L=ZMEAN-1.282*SDU
      P10U=ZMEAN-1.282*SDL
      P90=ZMEAN+1.282*SD
      P90L=ZMEAN+1.282*SDL
      P90=ZMEAN+1.282*SD
      P90 I=ZMEAN+1.282*SDU
      P90U=ZMEAN+1.282*SDU
C
C OUTPUT STATISTICAL PARAMETERS OF INCIPIENT COLLAPSE PRESSURE
      PRINT 100,ZMEAN,ZMEANL,ZMEANU,SD,SDL,SDU,P10,P10L,P10U,
+       P90,P90L,P90U
      PRINT 105,INDEX,STDERR
      GOTO 999
C
C 95% CONFIDENCE INTERVAL IS NOT WITHIN 10% FOR BOTH MEAN AND 90
R
C VALUES -- THEREFORE OBTAIN 5 ADDITIONAL SAMPLES
   61 ICHECK=ICHECK+5
      RETURN
C
   86 FORMAT(/*INPUT MEAN AND STANDARD DEVIATION FOR FO*,*)
   87 FORMAT(/*INPUT MEAN AND STANDARD DEVIATION FOR S*,*)
   90 FORMAT(F9.2,F11.2,F10.2,F14.3)
   92 FORMAT(F9.1,F11.2,F10.2,F14.3)
   96 FORMAT(///,5X,*FOY*,9X,*S*,8X,*PSO*,6X,*COLLAPSE TIME*)
  100 FORMAT(///,11X,*STATISTICAL PROPERTIES OF INCIPIENT PSO*,
+       //,39X,*95% CONFIDENCE LIMITS*,/,7X,*ITEM*,18X,
+       *VALUE         LOWER         UPPER*,//,* MEAN*,F29.2,
+       2F12.2,//,* STANDARD DEVIATION*,F15.2,2F12.2,//,
+       * 10% PROBABILITY VALUE*,3F12.2,//,
+       * 90% PROBABILITY VALUE*,3F12.2)
  105 FORMAT(//,5X,*NUMBER OF OBSERVATIONS =*,I3,/,5X,
+       *STANDARD ERROR =*,F5.2)
C
  999 STOP$ END
FUNCTION XNORM1(X,A,B)
IF(X)10,20,20
10 X0=RANF(-1.0)
20 X1=RANF(0.0)
X2=RANF(0.0)
Y=SQRT(-2.0*ALOG(X1))*(COS(6.283184*X2))
XNORM1=A+Y*B
RETURN
END
```

RCSLAB

Reinforced Concrete Slab

PROGRAM RCSLAB

```
PROGRAM RCSLAB1 (INPUT,OUTPUT,TAPE1)
CALL RETR(7HRCSLAB2,7HRCSLAB2)
C * THIS PORTION OF THE PROGRAM INPUTS THE REQUIRED ELEMENT AND
C:  LOAD DATA AND INITIALIZES CERTAIN PARAMETERS *
C
COMMON KINC,LDTYPE,KRF,KRAND,TIME,I,Y(80),Q,QU,YU,YFAIL,
+  ZLS,ZLL,HS,PV,FPC,FDY,ICASE,NBBAR,AS(4),APS(4),D(4),DP(4),FDC,
+  EC,ES,R,ALP,ALP2,AREA,ZMASS,VFAIL,ZKLM,VL1,VL2,VS1,VS2,
+  MEMB,ASCL,ASCS,VCL,VCS,ASS,BSS,AF,BF,CF,NK,
+  W,PO,CO,LOC,S,ZLEN,CD,PSO,PDO,PR,PEXT,PC,TC,TQ,DELAY,
+  NMIN,RHOO,V3,L1,AA(9,2),NN(8),AFRONT,ASIDE,G,G2,G3,G4,PHO,DT
LOGICAL L1
C
C:  READ TITLE AND CONTROL PARAMETERS
PRINT 67
READ 68,TITLE
PRINT 85
READ,KINC,LDTYPE,KRF,KRAND
DELAY=0
VFAIL=1E10
67 FORMAT(/*INPUT TITLE*,*)
68 FORMAT(A39)
85 FORMAT(/*INPUT KINC,LDTYPE,KRF,KRAND(1=RANDOM)*,*)
C
4 DO 5 I=1,4
AS(I)=0
5 CONTINUE
C
C * INPUT AND ECHO SLAB AND REINFORCEMENT PROPERTIES *
PRINT 615
READ,ZLS,ZLL,HS,FPC,FDY,ICASE,NBBAR
FDC=1.25*FPC
EC=57619.0*SQRT(FPC)
ES=29E6
AREA=ZLS*ZLL
ECKIP=EC/1000$ ESKIP=ES/1000
R=ZLL/ZLS
ALP=1.0/R$ ALP2=ALP*ALP
IF(ICASE.LE.4)GOTO 11
R=0$ ALP=0$ ALP2=0
11 PRINT 670
DO 8 I=1,4
PRINT 625,I
READ,AS(I),D(I),APS(I),DP(I)
IF(I.NE.1)GOTO 3
GOTO(9,8,8,8,9,7,7),ICASE
3 GOTO(9,8,7,6,9,9,9),ICASE
6 IF(I.EQ.3)GOTO 9
GOTO 8
7 I=I+1
8 CONTINUE
9 CONTINUE
PRINT 711
READ,MEMB
IF(MEMB.NE.1)GOTO 15
IF(ICASE.GT.4)GOTO 13
PRINT 701
READ,ASCS,ASCL
ASCL=ASCL/12.0
GOTO 16
13 PRINT 706
READ,ASCS
ASCL=0.0
16 ASCS=ASCS/12.0
C
C: ************************************************
C: * DETERMINE DEFLECTION AND MOMENT COEFFICIENTS *
C: ************************************************
C
15 ZMASS=150.0*AREA*HS/(356.07*1728.0)
PRINT 620,ICASE,ZLS,ZLL,HS,FPC,FDC,ECKIP,FDY,ESKIP
PRINT 630
DO 110 I=1,4
IF(AS(I).EQ.0)GOTO 110
```

PROGRAM RCSLAB (CONTINUED)

```
P=AS(I)/(12.0*D(I)) $ PP=APS(I)/(12.0*D(I))
PRINT 640,I,AS(I),P,D(I),APS(I),PP,DP(I)
C   CHANGE UNITS OF REINFORCEMENT FROM SQ.IN./FT TO ...
AS(I)=AS(I)/12.0 $ APS(I)=APS(I)/12.0
110 CONTINUE
C
VCL=2.2*SQRT(FPC)/(1-2*D(1)/ZLS)+3000*(AS(1)/D(1))/(1-D(1)/ZLS)
VCLMAX=3.5*SQRT(FPC)/(1.0-2.0*D(1)/ZLS)
IF(VCL.GT.VCLMAX)VCL=VCLMAX
IF(ICASE.GT.2)GOTO 30
VCS=2.2*SQRT(FPC)/(1-2*D(2)/ZLL)+3000*(AS(2)/D(2))/(1-D(2)/ZLL)
VCSMAX=3.5*SQRT(FPC)/(1.0-2.0*D(2)/ZLL)
IF(VCS.GT.VCSMAX)VCS=VCSMAX
PRINT 680,VCL,VCS
GOTO 35
30 PRINT 685,VCL
35 CONTINUE
CALL CSEZ(ICASE,R,ASS,BSS,AF,BF,D,D,ZLS,ZLL,PV,NS,CF,EC,I)
615 FORMAT(/*INPUT LS,LL,HS,F'C,FDY,ICASE,NBARR*,*)
625 FORMAT(*INPUT AS,D,A'S,D' FOR SECTION*,I2,*)
620 FORMAT(//*PROPERTIES OF REINFORCED CONCRETE SLAB --*,
*        * SUPPORT TYPE IS*,I2,/,
*        * LS =*,F6.1,* IN.    LL =*,F6.1,* IN.*,6X,*HS =*,
*        F6.1,* IN.*,/,* F'C =*,F7.1,* PSI    FDC =*,F7.1,
*        * PSI*,5X,*EC =*,F7.1,* KSI*,/,* FDY =*,F4.1,* PSI*,
*        3X,*ES =*,F5.1,* KSI*)
635 FORMAT(//*REINFORCEMENT VALUES*/* SECTION     AS      (P)*,
*        9X,*D*,8X,*A'S     (P')*,8X,*D'*,/,3X,*(SQ IN./FT)*,10X,
*        *(IN.)   (SQ IN./FT)*,10X,*(IN.)*)
640 FORMAT(I5,F11.4,* (*,F6.4,*)*,F9.3,F10.3,* (*,F6.4,*)*,F9.3)
670 FORMAT(1H )
680 FORMAT(/*VCL =*,F6.1,* PSI     VCS =*,F6.1,* PSI*)
685 FORMAT(/*VCL =*,F6.1,* PSI*)
701 FORMAT(/*INPUT CONTINUOUS REINFORCEMENT PARALLEL TO *,
*        *SHORT AND*,/,*LONG SPANS (SQ IN./FT)*,*)
706 FORMAT(/*INPUT CONTINUOUS REINFORCEMENT PARALLEL TO *,
*        *SHORT SPAN (SQ IN./FT)*,*)
711 FORMAT(/*IS TENSILE MEMBRANE TO BE INCLUDED (0=NO)*,
*        *(1=YES)*,*)
C
C  INPUT LOAD PARAMETERS
IF(LDTYPE.EQ.5)GOTO 20
C  LOCATION 1.  FRONT FACE LOADING (USED IN BEAM-FILLING PROCEDURE
100 W=1000.0 $ P3=14.7 $ C3=1120.0
IF(KPF.NE.1)GOTO 102
LOC=1
IF(KRAN.EQ.1)GOTO 104
PRINT 600
READ,S
GOTO 105
C  LOCATION 2.  TOP FACE LOADING
102 CD=0 $ LOC=2
ZLEN=ZLS/12.0
105 IF(KINC.EQ.1)GOTO 106
PRINT 610
READ,PS3
PR=3.0*PS3*(7.0*P3+4.0*PS3)/(7.0*P3+PS3)
600 FORMAT(/*INPUT S*,*)
610 FORMAT(/*INPUT PS3*,*)
C
C * INPUT BEAM-FILLING PARAMETERS *
106 IF(KBF.EQ.0)GOTO 20
10 PRINT 700
RHOO=0.076 $ LI=.FALSE.
DELAY=1E10
READ,NWIN,V3
AT=0$ AFRONT=0$ ASIDE=0
DO 14 I=1,NWIN
PRINT 710,I
READ,AA(I,1),NN(I),AA(I,2)
AA(I,2)=AA(I,2)/1000.0
AT=AT+AA(I,1)
N=NN(I)$ GOTO(12,14,14),N
12 AFRONT=AFRONT+AA(I,1)
```

PROGRAM RCSLAB (CONTINUED)

```
GOTO 18
14 ASIDE=ASIDE+AA(I,1)
18 IF(AA(I,2).LT.DELAY)DELAY=AA(I,2)
AFRONT=AFRONT/AT$ ASIDE=ASIDE/AT
700 FORMAT(/*INPUT NWIN AND ROOM VOLUME (CF)*,+)
710 FORMAT(/*INPUT AREA (SQ FT),LOCATION CODE & DELAY(MSEC)*
+     * FOR WINDOW*,I2,+)
G=1.4 $ G2=1./G $ G3=1.-G2 $ G4=2./G3 $ G5=G+1.
PP2=.1912
C=SQRT(G*P0*32.*144./RHO3)
TAU=2.*(V3**(1./3.))/C
DT=TAU/4.0
C
20 CONTINUE
25 CALL CHAIN(RCSLAB2)
99 STOP
END
SUBROUTINE COEF(ICASE,R,ASS,BSS,AF,BF,I,ZLV,ZLH,PV,NX,CF,
+      E,IENTRY)
C:  THIS SUBROUTINE DETERMINES MOMENT AND DEFLECTION COEFFICIENTS
C:  FOR ONE-WAY (CASES 5-7) AND TWO-WAY (CASES 1-4) ELEMENTS
C
       REAL I,MPR,MPR ),NU
       NX=1
        IF(ICASE.GT.4)GOTO 50
C
        R2=R*R
        R3=R*R2
        R4=R2*R2
        ASS=-.007030+.013890*R-.003456*R2+.000286*R3
        BSS=-.058332+.139314*R-.035609*R2+.003016*R3
 9      GOTO(41,20,30,40),ICASE
C
C:  CASE 2. FIXED ON FOUR SIDES
 20    NX=3
        AF=-.003430+.007327*R-.003365*R2+.0006646*R3-.00004766*R4
        BF=-.101150+.260875*R-.138982*R2+.034677*R3-.004016*R4
+    +.000170*R**5
       CF=-.1674+.3554*R-.1714*R2+.0286*R3
        GOTO 41
C
C:  CASE 3. FIXED ON SHORT SIDES, SIMPLY SUPPORTED ON LONG SIDES
 30    NX=4
        AF=.004513-.017525*R+.023095*R2-.010325*R3+.002187*R4
+    -.0002205*R**5 + .00000840*R**6
        BF=-.122149+.313445*R-.153979*R2+.036192*R3-.004015*R4
+    +.0001646*R**5
       CF=2.1958-7.7564*R+10.8376*R2-7.2495*R3+2.344*R4
+           -.2954*R**5
        GOTO 41
C
C:  CASE 4. SIMPLY SUPPORTED ON SHORT SIDES, FIXED ON LONG SIDES
 40    NX=3
        AF=-.002765+.006652*R-.005498*R2+.001829*R3-.0002859*R4
+    +.00001739*R**5
        BF=-.060320+.256515*R-.175648*R2+.057928*R3-.009227*R4
+    +.000569*R**5
CF=5.8957*R-1.6669-7.9398*R2+5.3142*R3-1.7623*R4+.2313*R**5
C
 41    IF(R.GT.2.0)CF=1.0/12.0
       RETURN
C
 50    CONTINUE
C:  CASE 5. ONE-WAY, SIMPLY SUPPORTED
       ASS=5.0/384.0
        BSS=0.125
        GOTO(270,270,270,270,270,60,70),ICASE
C:  CASE 6. ONE-WAY, FIXED ENDS
C:  CASE 6. ONE-WAY FIXED END WALL
 60      AF=1.0/384.0
         BF=1.0/12.0
       CF=1.0/12.0
       NX=3
       RETURN
```

PROGRAM RCSLAB (CONTINUED)

```
C
C:  CASE 7. ØNE-WAY, PRØPPED CANTILEVER
 70     AF=1.0/185.0
        BF=0.125
       CF=0.125
       NX=3
 270   RETURN
       END
 SEGMENT RCSLAB2 (INPUT,ØUTPUT,TAPE1)
C  THIS SEGMENT CALCULATES THE RESISTANCE FUNCTIØN AND
C  LØADING AND SØLVES THE DYNAMIC EQUATIØNS ØF MØTIØN
C
 CØMMØN KINC,LDTYPE,KRF,KRAND,TIME,I,Y(80),Q,QU,YU,YFAIL,
+  ZLS,ZLL,HS,PV,FPC,FPY,ICASE,NØBAR,AS(4),APS(4),D(4),DP(4),FDC,
+  EC,ES,R,ALP,ALP2,AREA,ZMASS,VFAIL,ZKLM,VL1,VL2,VS1,VS2,
+  ME4B,ASCL,ASCS,VCL,VCS,ASS,BSS,AF,BF,CF,NX,
+  W,PØ,CØ,LØC,S,ZLEN,CD,PSØ,PDØ,PF,PEXT,PC,TC,TØ,DELAY,
+  NWIN,RHØØ,VØ,L1,AA(8,2),NN(8),AFRØNT,ASIDE,G,G2,G3,G4,PP2,DT
 CØMMØN /SAR/ SAREAS,SAREAL
 CØMMØN /RAND/ TIMEC
 DIMENSIØN A(80),V(80),T(80),VS(80),VL(80),PN(80)
C
 IF(KINC.NE.1.ØR.LDTYPE.EQ.5)CALL FØRCE(1)
 14    IF(KRAND.NE.1)GØTØ 35
       CALL FØRCE(4)
       CALL RANDØM(1)
 34    CALL RANDØM(2)
 35    CALL RESIST(3)
C
C: MINIMUM, MAXIMUM, AND STARTING VALUES ARE DETERMINED FØR CASES
C: WHERE THE LØAD CAUSING INCIPIENT CØLLAPSE IS TØ BE FØUND
 13    IF(KINC.EQ.0)GØTØ 23
        PF=QU
        PFMAX=0
        PFMIN=PF/2.0
       GØTØ 20
 16     PF=(PFMIN+PFMAX)/2.0
 20    CALL FØRCE(2)
 23    IF(KRF.EQ.0)GØTØ 24
       CALL FILL(PINT,2)
C
C: INITIALIZE VALUES FØR BETA METHØD (BETA = 1/6) AND CØMPUTE VALU
C: FØR FIRST TIME INTERVAL ASSUMING ELEMENT INITIALLY AT REST
 24     I=1
        TIME=0
       T(1)=0$ V(1)=0$ Y(1)=0
        DELTA=0.001
       IF(KRF.NE.1)GØTØ 30
 27    IF(TIME.GE.(DELAY-.00001))GØTØ 30
       TIME=TIME+DELTA
 CALL FILL(PINT,3)
       GØTØ 27
 IF(Y(I).GE.YFAIL)PRINT 71,T(I),Y(I)
 30    CALL RESIST(2)
       A(1)=0.0 $ VS(1)=0.0 $ VL(1)=0.0
       T(1)=TIME
C
C: PRØCEDURE FØR ALL SUBSEQUENT TIME INTERVALS
 1      I=I+1
 IF(I.LT.81)GØTØ 11
       PRINT 98,TIME
 98 FØRMAT(/*I=81:  TIME =*,F6.3,*  FAILURE ASSUMED TØ NØT ØCCUR*)
       GØTØ 6
 11    TIME=TIME+DELTA
        T(I)=TIME
        A(I)=A(I-1)
       IF(KRF.NE.0)GØTØ 10
       CALL FØRCE(3)
       PN(I)=PEXT
       GØTØ 2
 10    CALL FILL(PINT,3)
       PN(I)=PINT
 2 CØNTINUE
       DØ 8 JJ=1,10
```

PROGRAM RCSLAB (CONTINUED)

```
      Y(I)=Y(I-1)+DELTA*V(I-1)+DELTA*DELTA*(A(I-1)/3.+A(I)/6.)
      CALL RESIST(2)
4     ANEW=AREA*(PN(I)-Q)/(ZMASS*ZKLM)
      ADELTA=ANEW-A(I)
      A(I)=ANEW
IF(ANEW.EQ.0)PRINT,*1985*,TIME,PN(I),Q,ZMASS,ZKLM,Y(I),A(I-1)
      IF(ABS(ADELTA/(ANEW+1E-10)).LT.0.01)GOTO 9
8     CONTINUE
      A(I)=ANEW-ADELTA/2.0
PRINT 80,TIME,PF,A(I),Y(I)
9     CONTINUE
      Y(I)=Y(I-1)+DELTA*V(I-1)+DELTA*DELTA*(A(I-1)/3.+A(I)/6.)
      V(I)=V(I-1)+DELTA*(A(I)+A(I-1))/2.0
      VS(I)=AREA*(VS1*PN(I)+VS2*Q)
      VL(I)=AREA*(VL1*PN(I)+VL2*Q)
C
C: CHECK FOR MAXIMUM DEFLECTION OR FAILURE OF WALL
C:    IF MAXIMUM DEFLECTION REACHED, ELEMENT DID NOT FAIL
      IF(Y(I).LE.Y(I-1).AND.PN(I).LE.PN(I-1))GOTO 6
      IF(Y(I).LT.0)GOTO 6
      IF(TIME-DELAY.GE.0.010)DELTA=0.002
      IF(TIME-DELAY.GE.0.020)DELTA=0.005
      IF(TIME-DELAY.GE.0.100)DELTA=0.010
      IF(TIME-DELAY.GE.0.500)DELTA=0.050
C  IF FAILURE DEFLECTION REACHED, WALL FAILED
      IF(Y(I).GE.YFAIL)GOTO 7
      GOTO 1
C
C: INTERVAL HALVING PROCEDURE TO DETERMINE LOAD CAUSING INCIPIENT
C: COLLAPSE FOR CASES WHERE DESIRED
C:   ELEMENT DID NOT FAIL -- SET PFMIN TO PF
6     CONTINUE
      IF(KINC.EQ.0)GOTO 18
36    PFMIN=PF
IF(PFMAX.GT.0)GOTO 16
PF=2.0*PF
      GOTO 20
C:   ELEMENT FAILED -- SET PFMAX TO PF
7     CONTINUE
      TIMEC=TIME
      IF(KINC.EQ.0)GOTO 18
37    PFMAX=PF
C:   CHECK TO SEE IF LOAD RANGE IS WITHIN DESIRED ACCURACY
17    IF((PFMAX-PFMIN)/PFMIN.GT.0.01)GOTO 16
      IF(KRAND.NE.1)GOTO 18
      CALL RANDOM(3)
      GOTO 34
C
C: OUTPUT DATA INCLUDES THE MAXIMUM DEFLECTION AND TIME OF
C: OCCURANCE FOR A NON-FAILING WALL OR THE TIME AND VELOCITY
C: AT COLLAPSE FOR A FAILING ELEMENT.  OPTIONAL OUTPUT
C: ENTIRE BEHAVIOR TIME-HISTORY OF THE WALL.
C
C: OUTPUT LOAD DATA
18    CALL FORCE(4)
C
C: OUTPUT FINAL RESULTS
IF(Y(I).LT.YFAIL)PRINT 70,Y(I),T(I)
IF(Y(I).GE.YFAIL)PRINT 71,T(I),V(I)
C
PRINT 90
READ,KFILE
IF(KFILE.EQ.0)GOTO 40
PRINT 95
READ,NAMEF
CALL PFUR(3HRET,1,NAMEF)
WRITE(1,)SAREAS,SAREAL,HS
WRITE(1,)I
WRITE(1,)(T(J),PN(J),VS(J),VL(J), J=1,I)
CALL PFUR(3HREP,1,NAMEF)
40 CONTINUE
C  CHECK TO SEE IF ENTIRE TIME-HISTORY IS DESIRED
PRINT 72
READ,M
```

PROGRAM RCSLAB (CONTINUED)

```
02600       IF(M.EQ.0)GOTO 25
02680 PRINT 76,(T(J),PN(J),A(J),V(J),Y(J),VS(J),VL(J),J=1,I)
02690 25 PRINT 77
02710C
02740 70 FORMAT(/*NO FAILURE - MAX. DEFLECTION OF*,F6.2,
02750+    * IN. REACHED*,F7.3,* SEC*)
02760 71 FORMAT(/*FAILURE OCCURRED AT*,F7.3,* SEC (FINAL VELOCITY =*,
02770+    F7.2,* IN./SEC)*)
02780 72 FORMAT(/*IS TIME HISTORY DESIRED (YES=1, NO=0)*,*)
02830 76 FORMAT(/*  TIME   PRESSURE  ACCELERATION  VELOCITY  *
02840+    *DISPLACEMENT    VS       VL*,/,
02850+    (F6.3,F9.3,F12.1,F12.2,F12.4,F11.0,F8.0))
02860 77     FORMAT(///,7(*-----------*))
02870 80 FORMAT(/*ACCELERATION NOT CONVERGING AT TIME =*,F6.3,
02880+            * SEC (PF =*,F7.3,* PSI)*/*      A(I) SET EQUAL TO*,
02890+            F8.1,* (AVG OF LAST 2 ITERATIONS)*/*      Y(I) =*,
02900+            F8.4,* IN.*)
02930 90 FORMAT(/*ARE REACTIONS TO BE OUTPUT TO FILE (0=NO,1=YES)*,*)
02940 95 FORMAT(/*INPUT NAME OF SLAB REACTION DATA FILE*,*)
02960 999    STOP
02970        END
10000 SUBROUTINE FORCE(IENTRY)
10010C  THIS SUBROUTINE INPUTS THE LOAD PARAMETERS AND DETERMINES
10020C  THE LOAD AT A GIVEN TIME FOR THE FOLLOWING LOAD TYPES:
10030C      1. IDEALIZED BLAST LOAD (FRONT OR SIDE FACE)
10050 COMMON KINC,LDTYPE,KRF,KRAND,TIME,I,Y(80),Q,QJ,YU,YFAIL,
10052+  ZLS,ZLL,HS,PV,FPC,FDY,ICASE,NOBAR,AS(4),APS(4),D(4),DP(4),FDC,
10054+  EC,ES,P,ALP,ALP2,AREA,ZMASS,VFAIL,ZKLM,VL1,VL2,VS1,VS2,
10055+  MEMB,ASCL,ASCS,VCL,VCS,ASS,RSS,AF,BF,CF,NK,
10056+  W,PO,CO,LOC,S,ZLEN,CD,PSO,PDO,PR,P,PC,TC,TO,DELAY,
10058+  NMIN,RHOO,VO,L1,AA(K,2),NN(K),AFRONT,ASIDE,G,G2,G3,G4,PP2,DT
10060 DIMENSION TT(20),PP(20)
10080C
10130 IF(LDTYPE.EQ.5)GOTO 500
10140C
10150 GOTO(215,200,300,400),IENTRY
11000C
11010C  CALCULATE LOAD PROPERTIES FOR GIVEN PEAK PRESSURE
11030 200 GOTO(205,210),LOC
11040 205 PSO=(PR-14.0*PO+SQRT(196.0*PO*PO+196.0*PO*PR+PR*PR))/16.0
11050 GOTO 215
11060 210 PSO=PR
11070 215 PDO=2.5*PSO*PSO/(7.0*PO+PSO)
11080 U=CO*SQRT(1.0+(6.0*PSO)/(7.0*PO))
11090 TO=W**0.3333/(2.2399+0.1896*PSO)
11100 GOTO(220,225),LOC
11110 220 TC=3.0*S/U
11120 PC=PSO*(1-TC/TO)*EXP(-TC/TO)+PDO*(1-TC/TO)**2*EXP(-2*TC/TO)
11130 CD=1.0
11140 RETURN
11150 225 TA=ZLEN/U
11160 TA2=TA/2.0
11170 TA2TO=TA2/TO
11180 PA=PSO*(1-TA2TO)*EXP(-TA2TO)+CD*PDO*(1-TA2TO)**2*EXP(-2*TA2TO)
11190 RETURN
12000C
12010C  CALCULATE LOAD
12030 300 GOTO(305,310),LOC
12040 305 TTO=TIME/TO
12050 IF(TIME.GT.TC)GOTO 320
12060 P=PC+(TC-TIME)*(PR-PC)/TC
12070 RETURN
12080 310 TTO=(TIME-TA2)/TO
12090 IF(TIME.GT.TA)GOTO 320
12100 P=PA*TIME/TA
12110 RETURN
12120 320 IF(TTO.GE.1.0)GOTO 330
12130 P=PSO*(1-TTO)*EXP(-TTO)+CD*PDO*(1-TTO)**2*EXP(-2*TTO)
12150 RETURN
12160 330 P=0
12170 RETURN
13000C
13010C  PRINT LOAD DATA
13020 400 IF(KINC.EQ.0)GOTO 490
```

PROGRAM RCSLAB (CONTINUED)

```
PRINT 640,LDTYPE
GOTO 410
400 PRINT 645,LDTYPE
410 CONTINUE
415 GOTO(420,425),L3C
420 PRINT 650
GOTO 430
425 PRINT 655
430 PRINT 660,W,PO,CO
IF(KRAND.NE.0)RETURN
GOTO(435,440),L3C
435 PRINT 665,S,TC,PR
GOTO 445
440 PRINT 670,ZLEN,TA,PA
445 PRINT 675,U,TO,CD,PSO,PDO
RETURN
C
C  LOAD TYPE 5 -- ARBITRARY LOAD SHAPE
500 GOTO(510,520,530,540),IENTRY
C
C  INPUT LOAD DATA
510 PRINT 680
READ,NPOINT,(TT(J),PP(J),J=1,NPOINT)
FACTOR=1.0
IF(KINC.EQ.0)GOTO 518
PMAX=PP(1)
DO 515 J=2,NPOINT
515 IF(PP(J).GT.PMAX)PMAX=PP(J)
518 PX=PP(2)-PP(1)
TX=TT(2)-TT(1)
JJ=1
RETURN
C
C  CALCULATE MAXIMUM LOAD
520 FACTOR=PR/PMAX
GOTO 518
RETURN
C
C  CALCULATE LOAD
530 IF(TIME.LE.TT(JJ+1))GOTO 535
JJ=JJ+1
PX=PP(JJ+1)-PP(JJ)
TX=TT(JJ+1)-TT(JJ)
IF(TX.EQ.0)TX=1E-10
GOTO 530
535 P=FACTOR*(PP(JJ)+(TIME-TT(JJ))*PX/TX)
RETURN
C
C  PRINT LOAD DATA
540 IF(KINC.EQ.1)PRINT 640,LDTYPE
IF(KINC.EQ.0)PRINT 645,LDTYPE
PRINT 690
DO 545 J=1,NPOINT
P=FACTOR*PP(J)
545 PRINT 695,TT(J),P
RETURN
C
640 FORMAT(/*LOAD CAUSING INCIPIENT FAILURE IS AS FOLLOWS:*,
+    /,5X,*LOAD TYPE NUMBER*,I2)
645 FORMAT(/*PROPERTIES OF LOAD ACTING ON ELEMENT ARE AS *
+    *FOLLOWS:*,/,5X,*LOAD TYPE NUMBER*,I2)
650 FORMAT(9X,*(FRONT FACE)*)
655 FORMAT(5X,*(SIDE OR TOP FACE)*)
660 FORMAT(10X,*W =*,F8.1,* KT   PO =*,F6.2,* PSI     CO =*,
+    F7.1,* FPS*)
665 FORMAT(10X,*S =*,F6.1,* FT     TC =*,F6.3,* SEC     PR =*,
+    F7.3,* PSI*)
670 FORMAT(10X,*L =*,F6.1,* FT     TA =*,F6.3,* SEC     PA =*,
+    F7.3,* PSI*)
675 FORMAT(10X,*U =*,F7.1,* FPS   TO =*,F6.3,* SEC     CD =*,
+    F5.1,/,5X,*PSO =*,F7.3,* PSI  PDO =*,F7.3,* PSI*)
680 FORMAT(/*INPUT NUMBER OF LOAD POINTS AND THE TIME AND *,
+    *PRESSURE AT EACH POINT*)
690 FORMAT(/10X,*TIME      PRESSURE*)
```

```
14170 605 FORMAT(F15.3,F12.2)
15000 END
20000 SUBROUTINE FILL(P3,IENTRY)
20010C: COMPUTES AVERAGE AIR PRESSURE IN ROOM DUE TO BLAST WAVE
20020C: INCIDENT HEAD-ON UPON FRONT WALL.
20030C
20050 COMMON KINC,LOTYPE,KRF,KRAND,TIME,II,Y(30),D,DD,YJ,YFAIL,
20052+   ZLS,ZLL,HS,PV,FPC,FDY,ICASE,NOBAR,AS(4),APS(4),D(4),DP(4),FDC,
20054+   EC,ES,DJM,ALP,ALP2,AREA,ZMASS,VFAIL,ZKLM,VL1,VL2,VF1,VF2,
20055+   HEMB,ASCL,ASCS,VCL,VCS,ASS,BSS,AF,BF,CF,NK,
20056+   M,P3,CO,LOC,S,ZLEN,CO,PSO,PDO,PR,PEXT,PC,TC,TO,DELAY,
20058+   NMIN,RHOO,V3,L1,AA(8,2),NN(8),AFRONT,ASIDE,G,G2,G3,G4,PP2,DT
20090 LOGICAL L1,L2,L3
20095C
20100 GOTO(10,13,11),IENTRY
20110 10 RETURN
20310C
20320 13 P33=P3
20330 TT=0.$ TO=0.
20340 RHO33=RHOO
20350 L2=.FALSE. $ L3=.FALSE.
20360 RETURN
20370C
20380 11 IF(L1)GOTO 52
20385 IF(L2.A.L3)GOTO 9
20390 52 DDT=(TIME-TO)*0.5
20395 ISTOP=2
20400 53 IF(DDT.LT.DT)GOTO 51
20410 50 DDT=0.5*DDT
20415 ISTOP=2*ISTOP
20420 GO TO 53
20430 51 CONTINUE
20440 DO 99 I=1,ISTOP
20450 TT=TO+I*DDT
20460 IF(TT.GT.TO)GO TO 99
20470 DM=0. $ WW=0. $ NW=0
20480 DO 500 K=1,NMIN
20490 M=NN(K) $ DLY=AA(K,2)+0.000001
20500 IF(DLY.GE.TT)GO TO 500
20510 GOTO(15,16,16),M
20520 15 CDF=1.0
20530 IF(TT-TC)20,20,21
20540 20  P11=(TC-TT)*(PR-PC)/TC+PC
20550 P11=P11+P3
20560 GO TO 30
20570 16 CDF=-0.4
20600 21  R=TT/TO $ RR=1.-R
20610 PD=PDO*RR*RR*EXP(-2.*R)
20620 PS=PSO*RR*EXP(-R)
20630 P11=PS+CDF*PD
20640 P11=P11+P3
20650 30  RHO1=RHO3*((P11/P3)**G2)
20660 IF(P11-P33)36,36,37
20670 36  JSIGN=-1
20680 L2=.TRUE.
20770 303  P2=P11
20780 RHO2=((P2/P33)**G2)*RHO33
20790 X=P33/RHO33
20800 GO TO 38
20810 37  JSIGN=+1
20820 306 P2=PP2*P11
20830 RHO2=((P2/P11)**G2)*RHO1
20840 X=P11/RHO1
20850 38  U22=G4*(X-P2/RHO2)*32.*144.
20860 IF(U22)40,39,39
20870 40  PRINT,*U22 NEGATIVE*,U22
20880 STOP
20890 39  U2=SQRT(U22)*JSIGN
20900 DDM=U2*RHO2*AA(K,1)*DDT
20910 DM=DM+DDM
20920 WW=WW+P11*DDM/(G3*RHO1)
20925C
20930 500 CONTINUE
20940 P33=P33+(G-1.)*WW/V3
```

```
20950 RHO33=RHO33+DM/V3
20960 99  CONTINUE
20970 T3=TT
20980 P3=P33-P3
20982 IF(TIME.GE.TC)L3=.TRUE.
20983 RETURN
20984 9 R=TIME/TO $ RR=1.0-R
20985 PD=PD0*RR*RR*EXP(-2.0*R)
20986 PS=PS0*RR*EXP(-R)
20987 P3=PS+PD*(AFRONT-0.4*ASIDE)
20990 999 RETURN
21020 END
30000 SUBROUTINE RESIST (IENTRY)
30010C: THIS SUBROUTINE INPUTS THE REQUIRED WALL DATA$ DETERMINES THE
30020C: RESISTANCE FUNCTION, TRANSFORMATION FACTORS, AND REACTION
30030C: COEFFICIENTS$ AND SUPPLIES THE REACTION VALUES FOR SPECIFIC
30040C: DEFLECTIONS REQUIRED IN THE DYNAMIC ANALYSIS
30045C
30050 COMMON KINC,LDTYPE,KRF,KRAND,TIME,I,Y(80),3,9U,YU,YFAIL,
30052+  ZLS,ZLL,HS,PV,FPC,FDY,ICASE,NOBAR,AS(4),APS(4),D(4),DP(4),FDC,
30054+  EC,ES,R,ALP,ALP2,AREA,ZMASS,VFAIL,ZKLM,VL1,VL2,VS1,VS2,
30055+  MEMB,ASCL,ASCS,VCL,VCS,ASS,BSS,AF,BF,CF,NK,
30056+  W,P3,C3,L3C,S,ZLEN,CD,PS3,PD3,PR,PEXT,PC,TC,TO,DELAY,
30058+  NWIN,RHO3,V3,L1,AA(8,2),NN(8),AFRONT,ASIDE,G,G2,G3,G4,PP2,DT
30070 COMMON /SAR/ SAREAS,SAREAL
30100 REAL N,IC,IG,MM,KK1,KK2,KK3,MU(4),ICR(4),KT
30130 GOTO(4,500,45),IENTRY
30140 4 RETURN
30810C
30820C: *******************************************
30830C: * ENTRY 2: DETERMINE ELEMENT PROPERTIES *
30840C: *             DEPENDENT ON FDC, FDY, AND D *
30850C
30860 45 N=ES/EC
30870 FR=8.0*SQRT(FDC)
30880 IG=HS**3/12+(N-1)*(AS(1)*(D(1)-HS/    *2+APS(1)*(HS/2-DP(1))**2)
30900 MM=2.0*IG*FR/HS
30920 CALL MOMENT(FDC,FDY,ES,N,0,1.0,AS,A/S,D,DP,MU,ICR,IC)
31490 GMU=MU(2)/MU(1)
31500C
31510C: DETERMINE POSITION OF YIELD LINES AND ULTIMATE RESISTANCE
31520C: COEFFICIENTS FOR TWO-WAY SLAB
31530 IF(ICASE.GT.4)GOTO 106
31540 ZI1=MU(4)/MU(2)
31550 ZI3=MU(3)/MU(1)
31560 GAMMA12=2.0*SQRT(1.0+ZI1)
31570 GAMMA34=2.0*SQRT(1.0+ZI3)
31580 GRAT=GAMMA12/GAMMA34
31590 B=SQRT(1+ZI1)*(GMU*ALP2/GAMMA34)*(SQRT(GRAT**2+3/
31600+  (GMU*ALP2))-GRAT)
31610C: IF BETA IS GREATER THAN 0.5 ASSUMPTION OF CRACK PATTERN A
31620C: NOT VALID AND CRACK PATTERN B IS ASSUMED TO OCCUR
31630 IF(B.LE.0.5)GOTO 105
31640C
31650C: CRACK PATTERN B
31660 KRACK=1
31670 B=SQRT(1.0+ZI3)*(SQRT(1.0/GRAT**2+GMU*ALP2*3.0)-1.0/GRAT)
31680+  /(GMU*ALP2*GAMMA12)
31690 OUTERM=6.0*GAMMA12**2*ALP*GMU/(SQRT(3+1/(GMU*ALP2*GRAT**2))
31700+  -1.0/(SQRT(GMU)*ALP*GRAT))**2
31705 SAREAS=0.5*ZLS*ZLL*(1.0-B) $ SAREAL=0.5*ZLS*ZLL*B
31710 GOTO 108
31720C
31730C: CRACK PATTERN A
31740 105 CONTINUE
31750 KRACK=0
31760 OUTERM=6.0*GAMMA34**2/(ALP*(SQRT(3+GMU*ALP2*GRAT**2)
31770+  -ALP*GRAT*SQRT(GMU))**2)
31775 SAREAS=0.5*ZLS*ZLL*B $ SAREAL=0.5*ZLS*ZLL*(1.0-B)
31780 GOTO 108
31790C
31800C: DETERMINE MOMENT AND DEFLECTION COEFFICIENTS
31810C: FOR CRACKED PORTION OF SLAB BEHAVIOR
31820 106 B=0
```

PROGRAM RCSLAB (CONTINUED)

```
      SAMEAS=0.0 $ SAREAL=0.5*ZLS*ZLL
  103 CØNTINUE
      GØTØ(195,195,195,195,182,185,190),ICASE
  182 QUTERM=1.0/(BSS*ZLS)
      GØTØ 195
  185 QUTERM=(MU(3)/MU(1)+1.0)/(BSS*ZLS)
      GØTØ 195
  190 QUTERM=(0.5*MU(3)/MU(1)+1.0)/(BSS*ZLS)
  195 GØTØ(200,210,210,210,200,210,210),ICASE
C
C: ************************************************************
C: * DETERMINE RESISTANCE CURVE FØR WALL                        *
C: * (Q IS IN UNITS ØF PSI, KK IN LB/CU.IN., AND Y IN INCHES)   *
C: ************************************************************
C
C: CASES 1 AND 5
  200 Q1=MM/(BSS*ZLS*ZLS)
      KK1=EC*IG/(ASS*ZLS**4)
      Y1=Q1/KK1
      KK2=EC*IC/(ASS*ZLS**4)
      IF(ICASE.EQ.5)GØTØ 205
      QU=QUTERM*MU(1)/AREA
      GØTØ 208
  205 QU=QUTERM*MU(1)/ZLS
  208 YU=QU/KK2
      GØTØ 280
C
C: CASES 2, 3, 4, 6, & 7
  210 Q1=MM/(BF*ZLS*ZLS)
      KK1=EC*IG/(AF*ZLS**4)
      Y1=Q1/KK1
      Q2=MU(NX)/(CF*ZLS*ZLS)
      KK2=EC*IC/(AF*ZLS**4)
      Y2=Q2/KK2
      KK3=EC*IC/(AFS*ZLS**4)
      IF(ICASE.GT.4)GØTØ 215
      QU=QUTERM*MU(1)/AREA
      GØTØ 220
  215 QU=QUTERM*MU(1)/ZLS
  220 YU=Y2+(QU-Q2)/KK3
  280 CØNTINUE
      QFAIL=QU
      YT=999.9
C
C: CHECK FØR TYPE ØF FAILURE - LIGHTLY REINFØRCED ØR CØNVENTIØNAL
      IF(MU(1).LT.1.5*MM)GØTØ 298
C
C: CØNVENTIØNAL TYPE FAILURE
      IF(ICASE.EQ.1.ØR.ICASE.EQ.5)GØTØ 272
      YE=Y2+YU*(1.0-Q2/QU)
      GØTØ 273
  272 YE=YU
  273 YFAIL=YE*0.1/(AS(1)/D(1))
C: DUCTILITY FACTØR MUST BE <= 30
      IF(YFAIL.GT.30.0*YE)YFAIL=30.0*YE
      GØTØ 300
C
C: LIGHTLY REINFØRCED TYPE ØF FAILURE
C:  THE FØLLØWING EXPRESSIØN IS BASED ØN A STEEL ELØNGATIØN ØF 20%
  298 UCØEF=30.0
      UPU=UCØEF*SQRT(FDC)
      ABAR=3.14159*(NØBAR/16.)**2
  290 YFAIL=SQRT((0.2*ABAR*FDY/UPU+ZLS/2.)**2-(ZLS/2.)**2)
C:
C  TENSILE MEMBRANE BEHAVIØR
  300 IF(MEMB.NE.1)GØTØ 885
      TS=ASCS*FDY
      IF(ASCL.EQ.0)GØTØ 312
      TL=ASCL*FDY
      C1=3.14159*SQRT(TS/TL)*ZLL/(2.0*ZLS)
      KT=0
      DØ 310 JJ=1,13,4
      JJ2=JJ+2
      CØSHJJ=0.5*(EXP(JJ*C1)+EXP(-JJ*C1))
```

```
32584 CØSHJJ2=0.5*(EXP(JJ2*C1)+EXP(-JJ2*C1))
32590 C2=(1.0-1.0/CØSHJJ)/JJ**3-(1.0-1.0/CØSHJJ2)/JJ2**3
32600 310 KT=KT+C2
32610 KT=1.5*3.14159**3/(4.0*KT)
32620 GØTØ 314
32630 312 KT=8.0*1.5
32640 314 YT=QU*ZLS*ZLS/(KT*TS)
32642 QT=QU
32644 IF(YT.LE.YFAIL)GØTØ 316
32646 YT=YFAIL
32648 QT=YT*KT*TS/(ZLS*ZLS)
32650 316 YFAIL=0.15*ZLS
32660 QFAIL=YFAIL*KT*TS/(ZLS*ZLS)
32665C
32670C * ADJUST LØAD-DEFLECTIØN CURVE FØR SLAB DEAD LØAD
32680 285 QDL=150.0*HS/1728.0
32700 IF(QDL.GT.Q1)GØTØ 292
32710 YDL=QDL/KK1
32712 GØTØ 295
32713 292 GØTØ(293,294,294,294,293,294,294),ICASE
32714 293 YDL=Y1+(QDL-Q1)*(YU-Y1)/(QU-Q1)
32715 IF(QDL.LT.QU)GØTØ 295
32716 PRINT,*QDL =*,QDL,*  QU =*,QU $ STØP
32717 294 YDL=Y1+(QDL-Q1)*(YU-Y1)/(QU-Q1)
32718 IF(QDL.LT.Q2)GØTØ 295 $ PRINT,*QDL =*,QDL,*  Q2 =*,Q2 $ STØP
32719 295 CØNTINUE
32720 Y1=Y1-YDL$ Y2=Y2-YDL$ YU=YU-YDL$ YT=YT-YDL$ YFAIL=YFAIL-YDL
32725 Q1=Q1-QDL$ Q2=Q2-QDL$ QU=QU-QDL$ QT=QT-QDL$ QFAIL=QFAIL-QDL
32730 IF(KRAND.NE.1)PRINT 633,QDL,YDL
32750C
32760C: ØUTPUT LØAD-DEFLECTIØN CURVE
32770 IF(KRAND.EQ.1)GØTØ 335
32780 PRINT 650
32790 IF(ICASE.EQ.1.ØR.ICASE.EQ.5)GØTØ 320
32800 PRINT 660,Q1,Y1,Q2,Y2
32810 GØTØ 330
32820 320 PRINT 660,Q1,Y1
32830 330 IF(MEMB.EQ.1)GØTØ 332
32840 PRINT 660,QU,YU,QFAIL,YFAIL
32850 GØTØ 335
32855 332 IF(QT.NE.QU)GØTØ 333
32860 PRINT 660,QU,YU,QT,YT,QFAIL,YFAIL
32862 GØTØ 335
32864 333 PRINT 660,QU,YU,QU,YT,QT,YT,QFAIL,YFAIL
32870 335 CØNTINUE
32880C
32890 CALL TRANS (R,ZLS,ZLL,ICASE,KRAK,ZKLMSE,ZKLMFE,ZKLMP,VL1S,VL2S,
32900+   VS1S,VS2S,VL1F,VL2F,VS1F,VS2F,VL1P,VL2P,VS1P,VS2P)
32910 QSHRL=VCL*D(1)*ZLL/((VL1S+VL2S)*AREA)
32920 IF(ICASE.GT.4)GØTØ 340
32930 QSHRS=VCS*D(2)*ZLS/((VS1S+VS2S)*AREA)
32940 IF(KRAND.NE.1)PRINT 690,QSHRL,QSHRS
32950 GØTØ 345
32960 340 IF(KRAND.NE.1)PRINT 695,QSHRL
32970 345 CØNTINUE
32980 RETURN
32990C
33000C: ***************************************************
33010C: * ENTRY 3: DETERMINE THE RESISTANCE (PER UNIT AREA) *
33020C: *            ØF THE WALL AS A FUNCTIØN ØF Y(1)       *
33030C: ***************************************************
33040C
33050 500 IF(Y(1).GE.YFAIL)GØTØ 560
33060 IF(Y(1).GT.YU)GØTØ 540
33070 GØTØ(501,520,520,520,501,520,520),ICASE
33080 501 CØNTINUE
33090C
33100C: ELASTIC RANGE -- CASES 1 AND 5
33110 ZKLM=ZKLMSE
33120 VL1=VL1S $ VL2=VL2S
33130 VS1=VS1S $ VS2=VS2S
33140 IF(Y(1).GT.Y1)GØTØ 510
33150C
33160C: UNCRACKED PØRTIØN -- ALL CASES
33170 505 Q=Y(1)*KK1
```

PROGRAM RCSLAB (CONTINUED)

```
33180 RETURN
33190C
33200C: CRACKED PORTION -- CASES 1 AND 5
33210 510 Q=Q1+(Y(I)-Y1)*(QU-Q1)/(YU-Y1)
33220 RETURN
33230C
33240 520 IF(Y(I).GT.Y2)GOTO 530
33250C
33260C: ELASTIC RANGE -- CASES 2,3,4,6,7
33270 ZKLM=ZKLMEF
33280 VL1=VL1F $ VL2=VL2F
33290 VS1=VS1F $ VS2=VS2F
33300 IF(Y(I).LT.Y1)GOTO 505
33310C: CRACKED PORTION -- CASES 2,3,4,6,7
33320 Q=Q1+(Y(I)-Y1)*(Q2-Q1)/(Y2-Y1)
33325 RETURN
33330C
33340C: ELASTO-PLASTIC RANGE -- CASES 2,3,4,6,7
33350 530 ZKLM=ZKLMSE
33360 VL1=VL1S $ VL2=VL2S
33370 VS1=VS1S $ VS2=VS2S
33380 Q=Q2+K3*(Y(I)-Y2)
33390 RETURN
33400C
33410C: PLASTIC RANGE -- ALL CASES
33420 540 ZKLM=ZKLMP
33430 VL1=VL1P $ VL2=VL2P
33440 VS1=VS1P $ VS2=VS2P
33450 IF(Y(I).GT.YT)GOTO 550
33460 Q=QU
33470 RETURN
33480C
33490C  TENSILE MEMBRANE RANGE -- ALL CASES
33500 550 Q=QT+(Y(I)-YT)*(QFAIL-QT)/(YFAIL-YT)
33510 RETURN
33520C
33530C: ELEMENT COLLAPSED - NO RESISTANCE (TO AVOID NUMERICAL DIFFICULTIES
33540C: FOR CERTAIN CASES SET RESISTANCE EQUAL TO VERY SMALL VALUE)
33550 560 Q=1E-10
33560 RETURN
33570C
33683 633 FORMAT(/*QDL =*,F6.2,* PSI      YDL =*,F8.4,* IN.*)
33700 650 FORMAT(//*LOAD-DEFLECTION CURVE*,/,3X,*Q (PSI)    Y (IN.)*)
33710 660 FORMAT(F9.2,F12.4)
33750 690 FORMAT(/*QSHRL =*,F9.2,* PSI      QSHRS =*,F9.2,* PSI*)
33760 695 FORMAT(/*QSHRL =*,F9.2,* PSI*)
33810 END
35000 SUBROUTINE MOMENT(FDC,FDY,ES,N,PV,B,AS,APS,D,DP,MU,ICR,IC)
35010C THIS SUBROUTINE DETERMINES THE ULTIMATE MOMENT CAPACITY AND
35020C CRACKED MOMENT OF INERTIA  FOR REQUIRED SECTIONS
35040 REAL K1,K2,K3,KUD,N,IC,ICTOT,MU(4),ICR(4),AS(4),APS(4),D(4),DP(4)
35050C
35060C: DETERMINE VALUES OF CONCRETE PARAMETERS
35070 45 K1=0.94-FDC/26E3
35080 K2=0.50-FDC/8E4
35090 K3=(3900.0+0.35*FDC)/(3E3+0.82*FDC-FDC*FDC/26E3)
35100 EPSC=0.004-FDC/65E5
35150C: ***************************************************
35160C: * DETERMINE ULTIMATE MOMENT CAPACITY AND CRACKED *
35170C: * MOMENT OF INERTIA FOR REQUIRED SECTIONS        *
35180C: ***************************************************
35190C
35200 II=0$ ICTOT=0
35210 DO 170 I=1,4
35220 IF(AS(I).EQ.0)GOTO 170
35230 II=II+1
35240C: ALL PROPERTIES ARE COMPUTED FOR A WIDTH B
35250 TENS=AS(I)*FDY*PV
35260 IF(APS(I).LE.0)GOTO 150
35270C
35280C: WALL HAS COMPRESSION REINFORCEMENT
35290 C=K1*K3*FDC*B*DP(I)
35300 TERM1=0.5*(TENS/APS(I)+ES*EPSC)
35310 TERM2=ES*EPSC*(TENS-C)/APS(I)
35320C: DETERMINE LOCATION OF NEUTRAL AXIS
```

PROGRAM RCSLAB (CONTINUED)

```
35330 IF(TENS.LE.C)GØTØ 140
35340C
35350C: KUD > D'
35360 FPS=TERM1+K3*FDC/2.0-SQRT((TERM1+K3*FDC/2.0)**2
35370+   -(TERM2+ES*EPSC*K3*FDC))
35380C: F'S MUST BE <= FDY
35390 IF(FPS.LT.FDY)GØTØ 130
35400 FPS=FDY
35410 130 TPS=APS(I)*(FPS-K3*FDC)
35420 KUD=(TENS-TPS)/(K1*K3*FDC*B)
35430 MU(I)=(TENS-TPS)*(D(I)-K2*KUD)+TPS*(D(I)-DP(I))
35440 ICR(I)=B*KUD**3/3.0+N*AS(I)*(D(I)-KUD)**2
35450+   +(N-1)*APS(I)*(KUD-DP(I))**2
35460 GØTØ 152
35470C
35480C: KUD < D'
35490 140 FPS=-TERM1+SQRT(TERM1**2-TERM2)
35500C: F'S MUST BE <= FDY
35510 IF(FPS.LT.FDY)GØTØ 145
35520 FPS=FDY
35530 145 TERM3=TENS+APS(I)*FPS
35540 KUD=TERM3/(K1*K3*FDC*B)
35550 MU(I)=TERM3*(D(I)-K2*KUD)-APS(I)*FPS*(D(I)-DP(I))
35560 ICR(I)=B*KUD**3/3+N*AS(I)*(D(I)-KUD)**2+N*APS(I)*(DP(I)-KUD)**2
35570 GØTØ 152
35580C
35590C: WALL HAS NØ CØMPRESSIØN REINFØRCEMENT
35600 150 KUD=TENS/(K1*K3*FDC*B)
35610 MU(I)=TENS*(D(I)-K2*KUD)
35620 ICR(I)=B*KUD**3/3.0+N*AS(I)*(D(I)-KUD)**2
35630C
35640 152 ICTØT=ICTØT+ICR(I)
35650 170 CØNTINUE
35660C
35670C: DETERMINE AVERAGE CRACKED MØMENT ØF INERTIA
35680 175 IC=ICTØT/II
35690 RETURN
35700 END
50000 SUBRØUTINE TRANS (B,ZLV,ZLH,ICASE,KRAK,ZKLMSE,ZKLMFE,ZKLMP,VL1S,
50010+   VL2S,VS1S,VS2S,VL1F,VL2F,VS1F,VS2F,VL1P,VL2P,VS1P,VS2P)
50030C
50040C: THIS SUBRØUTINE DETERMINES LØAD AND MASS TRANSFØRMATIØN FACTØRS
50050C: AND DYNAMIC REACTIØN CØEFFICIENTS FØR TWØ-WAY WALLS.
50060C
50070C: DETERMINE LØAD AND MASS TRANSFØRMATIØN FACTØRS
50080         B2=B*B
50090         B3=B*B2
50100         B4=B2*B2
50110         B5=B2*B3
50120         B6=B3*B3
50130C
50140C: CASES 1 & 5 -- ELASTIC RANGE
50150 330   ZKMSE1=20.48*B3*(1./12.-B2/7.5+B3/21+B4/14-B5/15+B6/90)
50160         ZKMSE2=0.5038-0.7066*B
50170         ZKLSE1=6.4*B2*(1./6.-B2/10.+B3/30.)
50180         ZKLSE2=0.64-0.8134*B
50190         BARS1=B*(1./12.-B2/15.+B3/42.)/(1./6.-B2/10.+B3/30.)
50200         BARS2=(0.127083-0.184524*B)/(0.4-0.508333*B)
50210         ZKMSE=ZKMSE1+ZKMSE2
50220         ZKLSE=ZKLSE1+ZKLSE2
50230         IF(KRAK.EQ.1)GØTØ 335
50240C: CRACK PATTERN A
50250         CVS=0.5*B
50260         CVL=0.5*(1.0-B)
50270         XP=ZLH*B/3.0
50280         XBARS=BARS1*ZLH
50290         ZP=ZLV*(1.0-4.0*B/3.0)/(4.0*(1.0-B))
50300         ZBARS=BARS2*ZLV
50310         XBARP=0.5*B*ZLH
50320         ZBARP=ZLV*(1./24.-B/16.)/(1./8.-B/6.)
50330         GØTØ 338
50340C: CRACK PATTERN B
50350 335   CVS=0.5*(1.0-B)
50360         CVL=0.5*B
50370         XP=ZLH*(1.0-4.0*B/3.0)/(4.0*(1.0-B))
```

```
      XBARS=BARS2*ZLH
      ZP=ZLV*B/3.0
      ZBARS=BARS1*ZLV
      XBARP=ZLH*(1./24.-B/16.)/(1./8.-B/6.)
      ZBARP=0.5*B*ZLV
 338  ZKLMSE=ZKMSE/ZKLSE
      GOTO(390,340,350,360,390,340,470),ICASE
C
C: CASES 2, 3, & 4 -- ELASTIC RANGE
 350  IF(KRAK.EQ.1)GOTO 365
      GOTO 340
 360  IF(KRAK.EQ.0)GOTO 365
C: CASES 2A, 2B, 3A, 4B, & 6
 340  ZKMFE1=512.0*B5*(1.0/30.-B/10.5+3.*B2/28.-B3/18.+B4/90.)
      ZKLFE1=32.0*B3*(1./12.-B/10.+B2/30.)
      BARF1=B*(.05-B/15.+B2/42.)/(1./12.-B/10.+B2/30.)
      GOTO(370,365,370,370,370,365),ICASE
C: CASES 2A, 2B, 3B, 4A, & 6
 365  ZKMFE2=0.4065-0.6144*B
      ZKLFE2=0.5344-0.7328*B
      BARF2=(.091667-.138095*B)/(.266667-.366667*B)
      GOTO(375,368,375,375,375,368),ICASE
C: CASES 2A & 2B
 368  ZKMFE=ZKMFE1+ZKMFE2
      ZKLFE=ZKLFE1+ZKLFE2
      GOTO 380
C:  CASES 3A & 4B
 370  ZKMFE=ZKMFE1+ZKMSE2
      ZKLFE=ZKLFE1+ZKLSE2
      GOTO 380
C: CASES 3B, 4A, & 6
 375  ZKMFE=ZKMSE1+ZKMFE2
      ZKLFE=ZKLSE1+ZKLFE2
 380  ZKLMFE=ZKMFE/ZKLFE
      GOTO 390
C: CASE 7
 470  ZKLMFE=0.78
C
C: ALL CASES -- PLASTIC RANGE
 390  ZKMP=(1.0-B)/3.0
      ZKLP=0.5-B/3.0
      ZKLMP=ZKMP/ZKLP
C
C
C: DETERMINE DYNAMIC REACTION COEFFICIENTS FOR SHORT (VS) AND
C: LONG (VL) EDGES
C
      IF(ICASE.LT.5)GOTO 395
      XBARS=1E-10$ BARF1=1E-10$ XBARP=1E-10
 395  CONTINUE
      GOTO(450,400,400,420,450,400,445),ICASE
 400  IF(KRAK.EQ.1)GOTO 410
      XBARF=BARF1*ZLH
      IF(ICASE.EQ.3)GOTO 430
 405  ZBARF=BARF2*ZLV
      GOTO 440
 410  XBARF=BARF2*ZLH
      IF(ICASE.EQ.3)GOTO 435
 415  ZBARF=BARF1*ZLV
      GOTO 440
 420  IF(KRAK.EQ.1)GOTO 425
      XBARF=BARS1*ZLH
      GOTO 405
 425  XBARF=BARS2*ZLH
      GOTO 415
 430  ZBARF=BARS2*ZLV
      GOTO 440
 435  ZBARF=BARS1*ZLV
 440  CONTINUE
C
C: CASES 2, 3, 4, & 6 -- ELASTIC RANGE
      VS1F=CVS*(1.0-XP/XBARF)
      VS2F=CVS*(XP/XBARF)
      VL1F=CVL*(1.0-ZP/ZBARF)
      VL2F=CVL*(ZP/ZBARF)
```

PROGRAM RCSLAB (CONTINUED)

```
      GOTO 450
C
C: CASE 7 -- ELASTIC RANGE
 445  VS1F=0
      VL1F=0.459
      VL2F=0.165
C
C: CASE 1 & 5 -- ELASTIC RANGE
 450  VS1S=CVS*(1.0-XP/XBARS)
      VS2S=CVS*(XP/XBARS)
      VL1S=CVL*(1.0-ZP/ZBARS)
      VL2S=CVL*(ZP/ZBARS)
C
C: ALL CASES -- PLASTIC RANGE
 460  VS1P=CVS*(1.0-XP/XBARP)
      VS2P=CVS*(XP/XBARP)
      VL1P=CVL*(1.0-ZP/ZBARP)
      VL2P=CVL*(ZP/ZBARP)
      RETURN
      END
      SUBROUTINE RANDOM (IENTRY)
C THIS SUBROUTINE INPUTS MEAN AND STANDARD DEVIATIONS FOR RANDOM
C VARIABLES;  GENERATES RANDOM VALUES;  AND CONTROLS REQUIRED
C NUMBER OF CASES TO BE RUN;  AND OUTPUTS FINAL RESULTS AND SUMMARY
C
 COMMON KINC,LDTYPE,KRF,KRAND,TIME,I,Y(30),Q,QU,YU,YFAIL,
+ ZLS,ZLL,HS,PV,FPC,FDY,ICASE,NBBAR,AS(4),APS(4),D(4),DP(4),FDC,
+ EC,ES,R,ALP,ALP2,AREA,ZMASS,VFAIL,ZKLM,VL1,VL2,VS1,VS2,
+ MEMB,ASCL,ASCS,VCL,VCS,ASS,BSS,AF,BF,CF,NX,
+ W,P0,C0,LOC,S,ZLEN,CD,PS0,PD0,PR,PEXT,PC,TC,TO,DELAY,
+ NWIN,RH00,V3,L1,AA(8,2),NN(8),AFRONT,ASIDE,G,G2,G3,G4,PP2,DT
    COMMON /RAND/ TIMEC
      DIMENSION CHI25(7),CHI975(7),TDIST(7)
C
C VALUES FOR 97.5%  (F=19,24,29,34,39,44,49)
      DATA CHI25/.4688,.5167,.5533,.5825,.6065,.6267,.6440/
      DATA CHI975/1.7295,1.6402,1.5766,1.5284,1.4903,1.4591,1.4331/
      DATA TDIST/2.093,2.064,2.045,2.032,2.022,2.016,2.010/
C
      GOTO(5,50,70),IENTRY
    5 XDUMMY=XNORM1(-1.0,0.0,1.0)
C INITIALIZE RANDOM NUMBER GENERATOR
      PRINT,/,*INPUT NRAND*,
      READ,NRAND
      DO 47 I=1,NRAND
      XDUMMY=XNORM1(0.0,0.0,1.0)
   47 CONTINUE
      INDEX=0$  SPSO=0$  SSPSO=0
      ICHECK=20
C
C  INPUT MEAN AND STANDARD DEVIATION FOR RANDOM VARIABLES
      IF(LOC.EQ.2)GOTO 30
      PRINT 87
      READ,SMEAN,SSD
C  REINFORCED CONCRETE WALLS
 30   PRINT 86
      READ,FDYMEAN,FDYSD
      IF(LOC.EQ.1)PRINT 96
      IF(LOC.NE.1)PRINT 95
      RETURN
C
C  GENERATE RANDOM VALUES
 50   FDY=XNORM1(0.0,FDYMEAN,FDYSD)
      IF(FDY.LE.0)GOTO 50
      IF(LOC.EQ.2.OR.SMEAN.EQ.0)GOTO 65
 60   S=XNORM1(0.0,SMEAN,SSD)
      IF(S.LE.0)GOTO 60
 65   INDEX=INDEX+1
      RETURN
C SUM VALUES OF PSO AND PSO**2 FOR USE IN STATISTICAL ANALYSIS
 70   SPSO=SPSO+PSO
      SSPSO=SSPSO+PSO*PSO
C
C OUTPUT FINAL RESULTS
 76   IF(LOC.EQ.1)PRINT 92,FDY,S,PSO,TIMEC
      IF(LOC.NE.1)PRINT 90,FDY,PSO,TIMEC
```

PROGRAM RCSLAB (CONCLUDED)

```
 80  IF(INDEX.LT.ICHECK)RETURN
C
C DETERMINE MEAN, STANDARD DEVIATION, AND STANDARD ERROR FOR PSO
      ZNO=INDEX
      ZMEAN=SPSO/ZNO
      SD=SQRT((SSPS)-ZNO*ZMEAN*ZMEAN)/ZNO)
      STDERR=SD/(SQRT(ZNO-1))
C CHECK IF MAXIMUM OF 50 PSO SAMPLES OBTAINED
      IF(INDEX.EQ.50)GOTO 62
C CHECK IF 95% CONFIDENCE INTERVAL FOR MEAN PSO VALUE IS
      IF(STDERR*TDIST((INDEX-15)/5)/ZMEAN.GT.0.10)GOTO 61
C
C CONFIDENCE INTERVAL IS WITHIN 10% -- DETERMINE UPPER LIMIT OF
C 95% CONFIDENCE INTERVAL FOR STANDARD DEVIATION
C PROBABILITY VALUE AND ITS 95% CONFIDENCE INTERVAL UPPER LIMIT
  62 SDU=SD/(SQRT(CHI25((INDEX-15)/5)))
C CHECK IF MAXIMUM OF 50 PSO SAMPLES OBTAINED
      IF(INDEX.EQ.50)GOTO 53
C CHECK IF UPPER VALUE OF 95% CONFIDENCE INTERVAL FOR STANDARD
C DEVIATION IS WITHIN 0.10*MEAN OF THE STANDARD DEVIATION
      IF(((SDU-SD)/ZMEAN).GT.0.10)GOTO 61
C
C 95% CONFIDENCE INTERVAL IS WITHIN 10% FOR BOTH MEAN AND 90%
C PROBABILITY VALUE -- THEREFORE SUFFICIENT SAMPLES OBTAINED
C DETERMINE 95% CONFIDENCE INTERVALS FOR MEAN, STANDARD DEVIATION
,
C AND 10% AND 90% PROBABILITY VALUES
  53 ZMEANL=ZMEAN-STDERR*TDIST((INDEX-15)/5)
      ZMEANU=ZMEAN+STDERR*TDIST((INDEX-15)/5)
      SDL=SD/(SQRT(CHI975((INDEX-15)/5)))
      P10=ZMEAN-1.282*SD
      P10L=ZMEAN-1.282*SDU
      P10U=ZMEAN-1.282*SDL
      P90=ZMEAN+1.282*SD
      P90L=ZMEAN+1.282*SDL
      P90=ZMEAN+1.282*SD
      P90U=ZMEAN+1.282*SDU
      P90U=ZMEAN+1.282*SDU
C
C OUTPUT STATISTICAL PARAMETERS OF INCIPIENT COLLAPSE PRESSURE
      PRINT 100,ZMEAN,ZMEANL,ZMEANU,SD,SDL,SDU,P10,P10L,P10U,
+       P90,P90L,P90U
      PRINT 105,INDEX,STDERR
      GOTO 999
C
C 95% CONFIDENCE INTERVAL IS NOT WITHIN 10% FOR BOTH MEAN AND 90
C
C VALUES -- THEREFORE OBTAIN 5 ADDITIONAL SAMPLES
  61 ICHECK=ICHECK+5
      RETURN
C
 86 FORMAT(/*INPUT MEAN AND STANDARD DEVIATION FOR FDY*,+)
 87 FORMAT(/*INPUT MEAN AND STANDARD DEVIATION FOR S*,+)
 90 FORMAT(F9.1,F10.2,F14.3)
 92 FORMAT(F9.1,F11.2,F10.2,F14.3)
 95 FORMAT(////,5X,*FDY*7X,*PSO*,6X,*COLLAPSE TIME*)
 96 FORMAT(////,5X,*FDY*,9X,*S*,8X,*PSO*,6X,*COLLAPSE TIM
 100 FORMAT(////,11X,*STATISTICAL PROPERTIES OF INCIPIENT F  O*,
+       //,39X,*95% CONFIDENCE LIMITS*,/,7X,*ITEM*,19X,
+       *VALUE        LOWER        UPPER*,//,* MEAN*,F29.2,
+       2F12.2,//,* STANDARD DEVIATION*,F15.2,2F12.2,//,
+       * 10% PROBABILITY VALUE*,3F12.2,//,
+       * 90% PROBABILITY VALUE*,3F12.2)
 105 FORMAT(//,5X,*NUMBER OF OBSERVATIONS  *,I3,/,5X,
+       *STANDARD ERROR =*,F5.2)
C
 999 STOP$ END
FUNCTION XNORM1(X,A,B)
IF(X)10,20,20
10 X0=RANF(-1.0)
20 X1=RANF(0.0)
X2=RANF(0.0)
Y=SQRT(-2.0*ALOG(X1))*(C .(6.2831854*X2))
XNORM1=A+Y*B
RETURN
END
```

RESTRAN

Restrained Reinforced Concrete Slab

PROGRAM RESTRAN

```
      PROGRAM RES (INPUT,OUTPUT)
C  THIS PROGRAM CALCULATES THE RESISTANCE OF A REINFORCED CONCRETE
C  SLAB RESTRAINED AGAINST LATERAL MOVEMENT AT THE EDGES
C
      COMMON KINC,LDTYPE,KRF,KRAND,TIME,I,Y(100),Q,QU,YU,YFAIL,FDC,
+  ZLS,HS,FDY,AREA,ZMASS,ZKLM,VS1,VS2,PSO,PDO,PF,PEXT,PC,TC,TO,
+  PO,DELAY,S,FPC,FY
      DIMENSION A(80),V(80),T(80),VS(80),QQ(80),PN(80)
      COMMON /RAND/ TIMEC
C
C  PRINT PROGRAM TITLE, DATE, AND TIME
5 DA=DATER(IDATE) $ CL=CLOCK(ICLOCK)
      PRINT 603,IDATE,ICLOCK
603 FORMAT(////*PROGRAM RESTRAN (REVISED 12/22/73)*,5X,A9,5X,A9)
C
C * READ TITLE AND CONTROL PARAMETERS *
      PRINT 67
      READ 68,TITLE
      PRINT 85
      READ,KINC,LDTYPE,KRF,KRAND
C
      DELAY=0
      CALL RESIST(1)
      IF(KRAND.NE.1)CALL RESIST(2)
      IF(LDTYPE.EQ.0)GOTO 50
      CALL FORCE(1)
      IF(KRF.EQ.0)GOTO 14
      CALL FILL(PINT,1)
14 IF(KRAND.NE.1)GOTO 13
      CALL FORCE(4)
      CALL RANDOM(1)
34 CALL RANDOM(2)
35 CALL RESIST(2)
C
C: MINIMUM, MAXIMUM, AND STARTING VALUES ARE DETERMINED FOR CASES
C: WHERE THE LOAD CAUSING INCIPIENT COLLAPSE IS TO BE FOUND
13     IF(KINC.EQ.0)GOTO 23
        PF=QU
        PFMAX=0
        PFMIN=PF/2.0
       GOTO 20
16      PF=(PFMIN+PFMAX)/2.0
20     CALL FORCE(2)
23     IF(KRF.EQ.0)GOTO 24
       CALL FILL(PINT,2)
C
C:  INITIALIZE VALUES FOR BETA METHOD (BETA=1/6) AND COMPUTE VALUES
C:  FOR FIRST TIME INTERVAL ASSUMING ELEMENT INITIALLY AT REST
24      I=1
        TIME=0
       V(1)=0 $ Y(1)=0
        DELTA=0.001
       IF(KRF.NE.1)GOTO 30
27     IF(TIME.GE.(DELAY-.00001))GOTO 30
       TIME=TIME+DELTA
       CALL FILL(PINT,3)
       GOTO 27
30 CALL RESIST(3)
       A(1)=0.0 $ VS(1)=0.0
       T(1)=TIME
C
C: PROCEDURE FOR ALL SUBSEQUENT TIME INTERVALS
1       I=I+1
       IF(I.LT.81)GOTO 11
       PRINT 98,TIME
98 FORMAT(/*I=81)  TIME =*,F6.3,*)  FAILURE ASSUMED TO NOT OCCUR*)
       GOTO 6
11     TIME=TIME+DELTA
        T(I)=TIME
        A(I)=A(I-1)
       IF(KRF.NE.0)GOTO 10
       CALL FORCE(3)
       PN(I)=PEXT
       GOTO 2
```

```
10   CALL FILL(PINT,3)
     PN(I)=PINT
2    CONTINUE
     DO 8 JJ=1,10
      Y(I)=Y(I-1)+DELTA*V(I-1)+DELTA*DELTA*(A(I-1)/3.+A(I)/6.)
CALL RESIST(3)
4    ANEW=AREA*(PN(I)-Q)/(ZMASS*ZKLM)
      ADELTA=ANEW-A(I)
      A(I)=ANEW
IF(ANEW.EQ.0)PRINT,*1985*,TIME,PN(I),Q,ZMASS,ZKLM,Y(I),A(I-1)
      IF(ABS(ADELTA/(ANEW+1E-10)).LT.0.01)GOTO 9
8     CONTINUE
      A(I)=ANEW-ADELTA/2.0
PRINT 80,TIME,PF,A(I),Y(I)
9     CONTINUE
      Y(I)=Y(I-1)+DELTA*V(I-1)+DELTA*DELTA*(A(I-1)/3.+A(I)/6.)
      V(I)=V(I-1)+DELTA*(A(I)+A(I-1))/2.0
     VS(I)=4.0*AREA*(VS1*PN(I)+VS2*Q)
     QQ(I)=Q
C
C: CHECK FOR MAXIMUM DEFLECTION OR FAILURE
C:    IF MAXIMUM DEFLECTION REACHED, WALL DID NOT FAIL
     IF(Y(I).LE.Y(I-1).AND.PN(I).LE.PN(I-1))GOTO 6
     IF(Y(I).LT.0)GOTO 6
     IF(Y(I).GE.YFAIL)GOTO 7
     IF(TIME-DELAY.GE.0.010)DELTA=0.002
     IF(TIME-DELAY.GE.0.020)DELTA=0.005
     IF(TIME-DELAY.GE.0.100)DELTA=0.010
     IF(TIME-DELAY.GE.0.500)DELTA=0.050
C:    IF FAILURE DEFLECTION REACHED, ELEMENT FAILED
      GOTO 1
C
C: INTERVAL HALVING PROCEDURE TO DETERMINE LOAD CAUSING INCIPIENT
C: COLLAPSE FOR CASES WHERE DESIRED
C:    ELEMENT DID NOT FAIL -- SET PFMIN TO PF
6    CONTINUE
     IF(KINC.EQ.0)GOTO 18
36   PFMIN=PF
IF(PFMAX.GT.0)GOTO 16
      PF=2.0*PF
      GOTO 20
C:    ELEMENT FAILED -- SET PFMAX TO PF
7    CONTINUE
     TIMEC=TIME
     IF(KINC.EQ.0)GOTO 18
37   PFMAX=PF
C:    CHECK TO SEE IF LOAD RANGE IS WITHIN DESIRED ACCURACY
17    IF((PFMAX-PFMIN)/PFMIN.GT.0.01)GOTO 16
     IF(KRAND.NE.1)GOTO 18
     CALL RANDOM(3)
     GOTO 34
C
C: OUTPUT DATA INCLUDES THE MAXIMUM DEFLECTION AND TIME OF
C: OCCURANCE FOR A NON-FAILING ELEMENT OR THE TIME AND VELOCITY
C: AT COLLAPSE FOR A FAILING ELEMENT.  OPTIONAL OUTPUT IS THE
C: ENTIRE BEHAVIOR TIME-HISTORY.
C
C: OUTPUT LOAD DATA
18    CALL FORCE(4)
C
C: OUTPUT FINAL RESULTS
IF(Y(I).LT.YFAIL)PRINT 70,Y(I),T(I)
IF(Y(I).GE.YFAIL)PRINT 71,T(I),V(I)
GOTO 42
C
C CHECK TO SEE IF ENTIRE TIME-HISTORY IS DESIRED
42 PRINT 72
READ,IPRINT
IF(IPRINT.EQ.0)GOTO 25
PRINT 76,(T(J),PN(J),A(J),V(J),Y(J),QQ(J),VS(J),J=1,I)
25 PRINT 77
GOTO 5
C
67 FORMAT(//*INPUT TITLE*,/)
```

PROGRAM RESTRAN (CONTINUED)

```
 68 FORMAT(A59)
 70 FORMAT(//*NO FAILURE - MAX DEFLECTION OF*,F6.2,
+    * IN. REACHED AT*F7.3,* SEC*)
 71 FORMAT(/*FAILURE OCCURRED AT*,F7.3,* SEC (FINAL VELOCITY =*,
+    F7.2* IN./SEC)*)
 72 FORMAT(/*IS TIME HISTORY DESIRED (YES=1, NO=0)*,↑)
 76 FORMAT(/*  TIME  PRESSURE  ACCELERATION  VELOCITY  *
+    *DISPLACEMENT    QQ      VS*,/,
+    (F6.3,F9.3,F12.1,F12.2,F12.4,F10.2,F9.0))
 77    FORMAT(///,7(*----------*))
 80 FORMAT(/*ACCELERATION NOT CONVERGING AT TIME =*,F6.3,
+            * SEC (PF =*,F7.3,* PSI)*/*     A(I) SET EQUAL TO*,
+            F8.1,* (AVG OF LAST 2 ITERATIONS)*/*     Y(I) =*,
+            F8.4,* IN.*)
 85 FORMAT(/*INPUT KINC,LDTYPE,KRF,KRAND(1=RANDOM)*,↑)
C
C  OUTPUT RESISTANCE FUNCTION (LDTYPE=0)
 50 I=1
 PRINT 60
 52 READ,YSTART,YEND,YINC
 IF(YINC.EQ.0)GOTO 25
 PRINT 62
 Y(I)=YSTART
 54 CALL RESIST(3)
 PRINT 63,Y(I),Q
 Y(I)=Y(I)+YINC
 IF(Y(I).LE.YEND)GOTO 54
 PRINT 61
 GOTO 52
C
 60 FORMAT(//*IF INTERMEDIATE VALUES OF RESISTANCE FUNCTION ARE *,
+    *TO BE PRINTED,*/*INPUT STARTING, ENDING, AND INCREMENTAL *,
+    *DEFLECTION VALUES*/*(IF NO INTERMEDIATE VALUES ARE *
+    *TO BE PRINTED, INPUT ZEROS)*)
 61 FORMAT(/*MORE VALUES*,↑)
 62 FORMAT(//*DEFLECTION (IN.)*,5X,*RESISTANCE (PSI)*)
 63 FORMAT(F11.4,F21.2)
C
 999 STOP
 END
 SUBROUTINE FORCE(IENTRY)
C  THIS SUBROUTINE INPUTS THE LOAD PARAMETERS AND DETERMINES
C  THE LOAD AT A GIVEN TIME FOR THE FOLLOWING LOAD TYPES:
C     1. IDEALIZED BLAST LOAD (FRONT OR SIDE FACE)
C
 COMMON KINC,LDTYPE,KRF,KRAND,TIME,I,Y(100),Q,QU,YU,YFAIL,FDC,
+ ZLS,HS,FDY,AREA,ZMASS,ZKLM,VS1,VS2,PSO,PDO,PR,P,PC,TC,TO,
+ PO,DELAY,S,FPC,FY
 DIMENSION TT(20),PP(20)
C
 IF(LDTYPE.EQ.5)GOTO 500
C
 GOTO(100,200,300,4),IENTRY
C
C * INPUT LOAD PARAMETERS *
C: LOCATION 1. FRONT FACE LOADING (USED IN ROOM-FILLING PROCEDURE)
 100 V=1000.0 $ PO=14.7 $ CO=1120.0
 IF(KRF.NE.1)GOTO 102
 LOC=1
 IF(KRAND.EQ.1)RETURN
 PRINT 600
 READ,S
 GOTO 105
C: LOCATION 2. TOP FACE LOADING
 102 CD=0 $ LOC=2
 ZLEN=ZLS/12.0
 105 IF(KINC.EQ.1)RETURN
 PRINT 610
 READ,PSO
 PR=2.0*PSO*(7.0*PO+4.0*PSO)/(7.0*PO+PSO)
 GOTO 215
C
C  CALCULATE LOAD PROPERTIES FOR GIVEN PEAK PRESSURE
 200 GOTO(205,210),LOC
```

PROGRAM RESTRAN (CONTINUED)

```
11040 205 PSO=(PR-14.0*PO+SQRT(196.0*PO*PO+196.0*PO*PR+PR*PR))/16.0
11050 GOTO 215
11060 210 PSO=PR
11070 215 PDO=2.5*PSO*PSO/(7.0*PO+PSO)
11080 U=CO*SQRT(1.0+(6.0*PSO)/(7.0*PO))
11090 TO=W**0.3333/(2.2399+0.1885*PSO)
11100 GOTO(220,225),LOC
11110 220 TC=3.0*S/U
11120 PC=PSO*(1-TC/TO)*EXP(-TC/TO)+PDO*(1-TC/TO)**2*EXP(-2*TC/TO)
11130 CD=1.0
11140 RETURN
11150 225 TA=ZLEN/U
11160 TA2=TA/2.0
11170 TA2TO=TA2/TO
11180 PA=PSO*(1-TA2TO)*EXP(-TA2TO)+CD*PDO*(1-TA2TO)**2*EXP(-2*TA2TO)
11190 RETURN
12000C
12010C  CALCULATE LOAD
12030 300 GOTO(305,310),LOC
12040 305 TTO=TIME/TO
12050 IF(TIME.GT.TC)GOTO 320
12060 P=PC+(TC-TIME)*(PR-PC)/TC
12070 RETURN
12080 310 TTO=(TIME-TA2)/TO
12090 IF(TIME.GT.TA)GOTO 320
12100 P=PA*TIME/TA
12110 RETURN
12120 320 IF(TTO.GE.1.0)GOTO 330
12130 P=PSO*(1-TTO)*EXP(-TTO)+CD*PDO*(1-TTO)**2*EXP(-2*TTO)
12150 RETURN
12160 330 P=0
12170 RETURN
13000C
13010C  PRINT LOAD DATA
13020 4 IF(KINC.EQ.0)GOTO 400
13030 PRINT 640,LDTYPE
13040 GOTO 410
13050 400 PRINT 645,LDTYPE
13060 410 CONTINUE
13070 415 GOTO(420,425),LOC
13080 420 PRINT 650
13090 GOTO 430
13100 425 PRINT 655
13110 430 PRINT 660,W,PO,CO
13120 IF(KRAND.NE.0)RETURN
13130 GOTO(435,440),LOC
13140 435 PRINT 665,S,TC,PR
13150 GOTO 445
13160 440 PRINT 670,ZLEN,TA,PA
13170 445 PRINT 675,U,TO,CD,PSO,PDO
13180 RETURN
13500C
13510C  LOAD TYPE 5 -- ARBITRARY LOAD SHAPE
13520 500 GOTO(510,520,530,540),IENTRY
13530C
13540C  INPUT LOAD DATA
13550 510 PRINT 680
13560 READ,NPOINT,(TT(J),PP(J),J=1,NPOINT)
13570 FACTOR=1.0
13580 IF(KINC.EQ.0)GOTO 518
13590 PMAX=PP(1)
13600 DO 515 J=2,NPOINT
13610 515 IF(PP(J).GT.PMAX)PMAX=PP(J)
13620 518 PX=PP(2)-PP(1)
13630 TX=TT(2)-TT(1)
13640 JJ=1
13650 RETURN
13660C
13670C  CALCULATE MAXIMUM LOAD
13680 520 FACTOR=PR/PMAX
13690 GOTO 518
13700 RETURN
13710C
13720C  CALCULATE LOAD
```

PROGRAM RESTRAN (CONTINUED)

```
13730 530 IF(TIME.LE.TT(JJ+1))GOTO 535
13740 JJ=JJ+1
13750 PX=PP(JJ+1)-PP(JJ)
13760 TX=TT(JJ+1)-TT(JJ)
13765 IF(TX.EQ.0)TX=1E-10
13770 GOTO 530
13780 535 P=FACTOR*(PP(JJ)+(TIME-TT(JJ))*PX/TX)
13790 RETURN
13800C
13810C  PRINT LOAD DATA
13815 540 IF(KINC.EQ.1)PRINT 640,LDTYPE
13820 IF(KINC.EQ.0)PRINT 645,LDTYPE
13825 PRINT 690
13830 DO 545 J=1,NPOINT
13840 P=FACTOR*PP(J)
13850 545 PRINT 695,TT(J),P
13860 RETURN
14000C
14010 600 FORMAT(//*INPUT S*,/)
14020 310 FORMAT(/*INPUT PSO*,/)
14070 640 FORMAT(/*LOAD CAUSING INCIPIENT FAILURE IS AS FOLLOWS:*,
14071+     /,5X,*LOAD TYPE NUMBER*,I2)
14080 645 FORMAT(/*PROPERTIES OF LOAD ACTING ON WALL ARE AS FOLLOWS:*,
14081+     /,5X,*LOAD TYPE NUMBER*,I2)
14090 650 FORMAT(8X,*(FRONT FACE)*)
14100 655 FORMAT(5X,*(SIDE OR TOP FACE)*)
14110 660 FORMAT(10X,*W =*,F8.1,* KT   PO =*,F6.2,* PSI      CO =*,
14111+     F7.1,* FPS*)
14120 665 FORMAT(10X,*S =*,F6.1,* FT      TC =*,F6.3,* SEC      PR =*,
14121+     F7.3,* PSI*)
14130 670 FORMAT(10X,*L =*,F6.1,* FT      TA =*,F6.3,* SEC      PA =*,
14131+     F7.3,* PSI*)
14140 675 FORMAT(10X,*U =*,F7.1,* FPS   TO =*,F6.3,* SEC      CD =*,
14141+     F5.1,/,8X,*PSO =*,F7.3,* PSI  PDO =*,F7.3,* PSI*)
14150 680 FORMAT(//*INPUT NUMBER OF LOAD POINTS AND THE TIME AND *
14151+     *PRESSURE AT EACH POINT*)
14160 690 FORMAT(/10X,*TIME       PRESSURE*)
14170 695 FORMAT(F15.3,F12.2)
15000 END
20000 SUBROUTINE FILL(P3,IENTRY)
20010 RETURN
20020 END
30000 SUBROUTINE RESIST (IENTRY)
30010C  THIS SUBROUTINE DETERMINES THE RESISTANCE FUNCTION,
30020C  TRANSFORMATION FACTORRS, AND REACTION COEFFICIENTS
30030C  FOR A LONGITUDINALLY RESTRAINED REINFORCED CONCRETE SLAB
30040C
30050 COMMON KINC,LDTYPE,KRF,KRAND,TIME,I,Y(100),Q,QU,YU,YFAIL,FDC,
30032+  ZLS,HS,FDY,AREA,ZMASS,ZKLM,VS1,VS2,PSO,PDO,PR,PEXT,PC,TC,TO,
30054+  PO,DELAY,S,FPC,FY
30080 COMMON /MOM/ AS(4),D(4),APS(4),DP(4),MU(4),R(4),
30085+  K1,K2,K3,EPSC,ES,FPS,KUD,E(4)
30090 REAL MU,K1,K2,K3,KUD,N,NUXO,NUXBLL,NUXAVG,NUZO,NUZLSR,NUZAVG
30095 REAL MU1BAR,MU2BAR,MU3BAR,MU4BAR,MU1,MU3,NB,KT
30100C
30110 GOTO (1,2,3), IENTRY
30120C
30130C  ENTRY 1. INPUT AND ECHO SLAB AND REINFORCEMENT PHOPERTIES
30150 1 PRINT 600
30160 READ,ZLS,ZLL,HS,FPC,FY,DIF
30165 PRINT 670
30170 DO 100 I=1,4
30180 PRINT 610,I
30190 P(I)=0.0
30200 READ,AS(I),D(I),APS(I),DP(I)
30240C  SLAB ASSUMED TO BE RESTRAINED AT CENTERLINE OF CROSS SECTION
30250 E(I)=0.0
30260 100 CONTINUE
30262 PRINT 711
30265 READ,ASCZ,ASCX
30266 ASCZ=ASCZ/12.0 $ ASCX=ASCX/12.0
30270 PRINT 602
30280 READ,SZ,SX
30281C
```

```
30282C  CALCULATE VARIOUS CONSTANTS
30283 DIF=1.0+DIF/100.0
30285 FDC=DIF*FPC $ FDY=DIF*FY
30300 ALP=ZLS/ZLL
30310 ALP2=ALP*ALP
30315 ES=29E6
30318 AREA=ZLS*ZLL
30319 ZMASS=150.0*AREA*HS/(386.07*1728.0)
30320C
30321C  OUTPUT SLAB PROPERTIES
30322 PRINT 620,ZLS,ZLL,HS,FDC,FDY
30323 PRINT 630
30324 DO 104 I=1,4
30325 IF(AS(I).EQ.0)GOTO 104
30326 P=AS(I)/(12.0*D(I)) $ PP=APS(I)/(12.0*D(I))
30327 PRINT 640,I,AS(I),P,D(I),APS(I),PP,DP(I)
30328C  CHANGE UNITS OF REINFORCEMENT FROM SQ.IN./FT TO SQ.IN./IN.
30329 AS(I)=AS(I)/12.0 $ APS(I)=APS(I)/12.0
30330 104 CONTINUE
30332 RETURN
30340C
30350C  ENTRY 2.  DETERMINE PROPERTIES DEPENDENT UPON FDY AND FDC
30360 2 EC=57619.03*SQRT(FPC)
30370 N=ES/EC
30380 FDC=DIF*FPC $ FDY=DIF*FY
30390 K1=0.94-FDC/26E3
30400 K2=0.50-FDC/8E4
30410 K3=(3900.0+0.35*FDC)/(3E3+0.82*FDC-FDC*FDC/26E3)
30420 EPSC=0.004-FDC/65E6
30430 DO 110 I=1,4
30440 110 CALL MOMENT (0.0,I,FDY,FDC,HS)
30450 IF(MU(1).GT.0.0)GOTO 120
30460 QUTERM=0.0
30470 B=0.5*(SQRT(3.0*ALP2+ALP2**2)-ALP2)
30480 GOTO 108
30490 120 GMU=MU(2)/MU(1)
30500C
30510C: DETERMINE POSITION OF YIELD LINES AND ULTIMATE RESISTANCE
30520C: COEFFICIENTS FOR TWO-WAY WALLS
30530 ZI1=MU(4)/MU(2)
30540 ZI3=MU(3)/MU(1)
30550 GAMMA12=2.0*SQRT(1.0+ZI1)
30560 GAMMA34=2.0*SQRT(1.0+ZI3)
30570 GRAT=GAMMA12/GAMMA34
30580 B=SQRT(1+ZI1)*(GMU*ALP2/GAMMA34)*(SQRT(GRAT**2+3/
30590+  (GMU*ALP2))-GRAT)
30600C: IF BETA IS GREATER THAN 0.5 ASSUMPTION OF CRACK PATTERN A
30610C: NOT VALID AND CRACK PATTERN B IS ASSUMED TO OCCUR
30620 IF(B.LE.0.5)GOTO 105
30630C
30640C: CRACK PATTERN B
30650 KRAK=1
30660 B=SQRT(1.0+ZI3)*(SQRT(1.0/GRAT**2+GMU*ALP2*3.0)-1.0/GRAT)
30670+  /(GMU*ALP2*GAMMA12)
30680 QUTERM=6.0*GAMMA12**2*ALP*GMU/(SQRT(3+1/(GMU*ALP2*GRAT**2))
30690+  -1.0/(SQRT(GMU)*ALP*GRAT))**2
30695 IF(KRAND.NE.1)PRINT 623
30696 623 FORMAT(/*CRACK PATTERN B -- RESULTS NOT FULLY CHECKED OUT*)
30700 GOTO 108
30710C
30720C: CRACK PATTERN A
30730 105 CONTINUE
30740 KRAK=0
30750 QUTERM=6.0*GAMMA34**2/(ALP*(SQRT(3+GMU*ALP2*GRAT**2)
30760+  -ALP*GRAT*SQRT(GMU))**2)
30765C
30770C  SECONDARY RESISTANCE
30780 108 QS=QUTERM*MU(1)/(ZLS*ZLL)
30785C
30790C  DETERMINE TRANSFORMATION FACTORS AND DYNAMIC REACTION COEFFICIENS
30795C  TRANSFORMATION FACTORS AND DYNAMIC REACTION COEFFICIENTS
30798 CALL TRANS (B,ZLS,ZLL,KRAK,ZKLMP,VL1P,VL2P,VS1P,VS2P)
30800 DO 200 I=1,4
308'  R(I)=(AS(I)-APS(I))*FDY/(K3*FDC)
```

```
200 CONTINUE
C  SET ELASTIC STRAIN TO ZERO
EAX=0.0 $ EAZ=0.0
SXP=SX+EAX $ SZP=SZ+EAZ
C
C  CALCULATE DEFLECTION AT ULTIMATE RESISTANCE
IYU=1
C  Z-DIRECTION STRIPS
TERM1=HS+(R(3)-R(1))/K1
TERM2=0.5*ZLS*ZLS*(EPSC*(1.0+SZ)+SZP)
GOTO 206
C  X-DIRECTION STRIPS
202 IYU=2
TERM1=HS+(R(4)-R(2))/K1
TERM2=B*ZLL*ZLL*(EPSC*(2.0*B+SX-2.0*B*EAX+EAX)+SXP)
206 IF(TERM2.GT.TERM1*TERM1)GOTO 210
YU=TERM1-SQRT(TERM1**2-TERM2)
IF(YU.LT.0.42*HS)GOTO 235
C  EMPIRICAL UPPER BOUND OF 0.42 TIMES SLAB THICKNESS FOR YU
210 YU=0.42*HS
235 CONTINUE
C
C  CALCULATE IN-PLANE COMPRESSIVE FORCES
NUZO=0.5*K3*FDC*((HS-0.25*SZP*ZLS*ZLS/YU)*K1-R(1)-R(3))
IF(NUZO.LT.0)NUZO=0
IF(NUZO.EQ.0.AND.IYU.EQ.1)GOTO 202
NUZLS2=NUZO-0.25*K3*FDC*K1*YU
IF(NUZLS2.LT.0)NUZLS2=0
NUZAVG=0.5*(NUZO+NUZLS2)
NUXO=0.5*K3*FDC*((HS-0.5*B*SXP*ZLL*ZLL/YU)*K1-R(2)-R(4))
IF(NUXO.LT.0)NUXO=0
NUXBLL=NUXO-0.25*K3*FDC*K1*YU
IF(NUXBLL.LT.0)NUXBLL=0
NUXAVG=0.5*(NUXO+NUXBLL)
C
C  CALCULATE ULTIMATE COMPRESSIVE MEMBRANE RESISTANCE
CALL MOMENT (NUXAVG,2,FDY,FDC,HS)
MU2BAR=MU(2)
CALL MOMENT (NUXAVG,4,FDY,FDC,HS)
MU4BAR=MU(4)
CALL MOMENT (NUZAVG,1,FDY,FDC,HS)
MU1BAR=MU(1)
CALL MOMENT (NUZAVG,3,FDY,FDC,HS)
MU3BAR=MU(3)
CALL MOMENT (NUZLS2,1,FDY,FDC,HS)
MU1=MU(1)
CALL MOMENT (NUZO,3,FDY,FDC,HS)
MU3=MU(3)
QU=12.0/(ZLS*ZLS*(3.0-2.0*B))*(((ZLS/ZLL)**2/B)*(MU2BAR
+ +MU4BAR-YU*(2.0*NUXBLL+NUXO)/6.0)+4.0*B*(MU1BAR+MU3BAR
+ -YU*(2.0*NUZLS2+NUZO)/6.0)+2.0*(1.0-2.0*B)*(MU1+MU3-YU*NUZLS2))
C
C  TENSILE MEMBRANE BEHAVIOR
TZ=ASCZ*FDY
TX=ASCX*FDY
IF(TZ.EQ.0.0.OR.TX.EQ.0)GOTO 312
C1=3.14159*SQR (TZ/TX)*ZLL/(2.0*ZLS)
KT=0
DO 310 JJ=1,13,2
JJ2=JJ+2
COSHJJ=0.5*(EXP(JJ*C1)+EXP(-JJ*C1))
COSHJJ2=0.5*(EXP(JJ2*C1)+EXP(-JJ2*C1))
C2=(1.0-1.0/COSHJJ)/JJ**3-(1.0-1.0/COSHJJ2)/JJ2**3
310 KT=KT+C2
KT=1.5*3.14159**3/(4.0*KT)
GOTO 314
312 KT=1.5*8.0
IF(TZ.EQ.0)GOTO 316
C
C  SECONDARY AND TENSILE MEMBRANE DEFLECTION
314 YT=QS*ZLS*ZLS/(KT*TZ)
YFAIL=0.15*ZLS
QFAIL=YFAIL*KT*TZ/(ZLS*ZLS)
GOTO 317
```

```
316 IF(TX.EQ.0)GOTO 318
C  NO TENSILE MEMBRANE REINFORCEMENT -- SET YS=YT=YFAIL=HS
YT=QS*ZLL*ZLL/(KT*TX)
YFAIL=0.15*ZLL
QFAIL=YFAIL*KT*TX/(ZLL*ZLL)
317 IF(YT.LT.3.0*YU)YS=YT
IF(YT.GT.3.0*YU)YS=3.0*YU
GOTO 320
C  NO TENSILE MEMBRANE REINFORCEMENT - SET YS=YFAIL=HS
318 YS=HS $ YT=HS $ YFAIL=HS $ QFAIL=0.0
C
C  ADJUST LOAD-DEFLECTION CURVE FOR SLAB DEAD LOAD
320 QDL=150.0*HS/172.0
YDL=YU-YU*(1.0-(QDL/QU)**1.8)**(1.0/1.8)
YU=YU-YDL $ YS=YS-YDL $ YT=YT-YDL $ YFAIL=YFAIL-YDL
QU=QU-QDL $ QS=QS-QDL $ QFAIL=QFAIL-QDL
IF(KRAND.NE.1)PRINT 633,QDL,YDL
C
C  OUTPUT LOAD-DEFLECTION CURVE
IF(KRAND.EQ.1)GOTO 335
IF(YS.EQ.YT)PRINT 660,QU,YU,QS,YS,QFAIL,YFAIL
IF(YS.NE.YT)PRINT 660,QU,YU,QS,YS,QS,YT,QFAIL,YFAIL
335 RETURN
C
600 FORMAT(/*INPUT LS,LL,HS,F'C,FY,DIF(%)*,↑)
602 FORMAT(/*INPUT LONGITUDINAL EDGE DISPLACEMENT (PER UNIT *,
+    *LENGTH)*/*IN SHORT AND LONG DIRECTIONS*,↑)
610 FORMAT(I6,↑)
620 FORMAT(//*PROPERTIES OF LONGITUDINALLY RESTRAINED *
+    *REINFORCED CONCRETE SLAB*,/,*  LS =*,F6.1,* IN.     LL =*,
+    F6.1,* IN.*,6X,*HS =*,F6.1,* IN.*,/,* FDC =*,F7.1,* PSI*,
+    *   FDY =*,F8.1,* PSI*)
630 FORMAT(/*REINFORCEMENT VALUES*,  SECTION    AS       (P)*,
+    7X,*D*,8X,*A'S     (P')*,7X,*D'*,/,8X,*(SQ IN./FT)*,10X,
+    *(IN.)  (SQ IN./FT)*,10X,*(IN.)*)
633 FORMAT(/*QDL =*,F6.2,* PSI      YDL =*,F8.4,* IN.*)
640 FORMAT(I5,F11.4,*    (*,F5.4,*)*,F8.3,F10.4,*    (*,F5.4,*)*,
+    F8.3)
660 FORMAT(/*LOAD-DEFLECTION CURVE*,/,4X,*Q (PSI)   Y (IN.)*,
+    /,(F9.2,F12.4))
670 FORMAT(/*INPUT AS, D, APS, AND DP FOR FOLLOWING SECTIONS*)
711 FORMAT(/*INPUT CONTINUOUS TENSILE MEMBRANE REINFORCEMENT *,
+    *(SQ IN./FT)*/*IN SHORT AND LONG DIRECTIONS*,↑)
C
C  ENTRY 3.  DETERMINE THE RESISTANCE (PER UNIT AREA)
C            OF THE SLAB AS A FUNCTION OF Y(I)
C
3 IF(Y(I).LT.0.OR.Y(I).GT.YFAIL)GOTO 530
IF(Y(I).GE.YU)GOTO 510
ZKLM=ZKLMP
C
C COMPRESSIVE MEMBRANE RESISTANCE
Q=QU*(1.0-(1.0-Y(I)/YU)**1.8)**(1.0/1.8)
RETURN
C
510 IF(Y(I).GE.YS)GOTO 520
C
C SECONDARY RESISTANCE
Q=0.5*(QU+QS+(QU-QS)*COS(3.1416*(Y(I)-YU)/(YS-YU)))
RETURN
C
520 IF(Y(I).GT.YT)GOTO 525
C
C  PLASTIC RESISTANCE
Q=QS
RETURN
C
C TENSILE MEMBRANE RESISTANCE
525 Q=QS+(Y(I)-YT)*(QFAIL-QS)/(YFAIL-YT)
RETURN
C
C FAILURE (SET RESISTANCE TO VERY SMALL VALUE)
530 Q=1E-11
RETURN
```

```
33000 END
35000 SUBROUTINE MOMENT (PV,I,FDY,FDC,HS)
35010C  THIS SUBROUTINE CALCULATES THE ULTIMATE MOMENT CAPACITY FOR
35020C  REQUIRED SECTIONS.  INCLUDED ARE THE EFFECT OF IN-PLANE FORCES
35030C  AT AN ECCENTRICITY E(I) FROM THE CROSS SECTION CENTERLINE.
35040 COMMON /MOM/ AS(4),D(4),APS(4),DP(4),MU(4),R(4),
35050+  K1,K2,K3,EPSC,ES,FPS,KUD,E(4)
35060 REAL MU,K1,K2,K3,KUD
35090C
35100 IF(AS(I).EQ.0)GOTO 170
35110C: ALL PROPERTIES ARE COMPUTED FOR A UNIT WIDTH
35120 TENS=AS(I)*FDY+PV
35130 IF(APS(I).LE.0)GOTO 150
35140C
35150C  SECTION HAS COMPRESSION REINFORCEMENT
35160 C=K1*K3*FDC*DP(I)
35170 TERM1=0.5*(TENS/APS(I)+ES*EPSC)
35180 TERM2=ES*EPSC*(TENS-C)/APS(I)
35190C: DETERMINE LOCATION OF NEUTRAL AXIS
35200 IF(TENS.LE.C)GOTO 140
35210C
35220C: KUD > D'
35230 FPS=TERM1+K3*FDC/2.0-SQRT((TERM1+K3*FDC/2.0)**2
35240+  -(TERM2+ES*EPSC*K3*FDC))
35250C: F'S MUST BE <= FDY
35260 IF(FPS.LT.FDY)GOTO 130
35270 FPS=FDY
35280 130 TPS=APS(I)*(FPS-K3*FDC)
35290 KUD=(TENS-TPS)/(K1*K3*FDC)
35300 MU(I)=AS(I)*FDY*(D(I)-K2*KUD)+APS(I)*FPS*(K2*KUD-DP(I))
35310+       +PV*(0.5*HS-K2*KUD+E(I))
35320 RETURN
35330C
35340C: KUD < D'
35350 140 FPS=-TERM1+SQRT(TERM1**2-TERM2)
35360C: F'S MUST BE <= FDY
35370 IF(FPS.LT.FDY)GOTO 145
35380 FPS=FDY
35390 145 TERM3=TENS+APS(I)*FPS
35400 KUD=TERM3/(K1*K3*FDC)
35410 MU(I)=AS(I)*FDY*(D(I)-K2*KUD)-APS(I)*FPS*(K2*KUD-DP(I))
35420+       +PV*(0.5*HS-K2*KUD+E(I))
35430 RETURN
35440C
35450C  SECTION HAS NO COMPRESSION REINFORCEMENT
35460 150 TERM1=0.5*(ES*EPSC+PV/AS(I))
35470 FS=-TERM1+SQRT(TERM1**2+ES*EPSC*(K1*K3*FDC*D(I)-PV)/AS(I))
35480 IF(FS.LT.FDY)GOTO 160
35490 FS=FDY
35500 160 IF(FS.LT.-FDY)FS=-FDY
35510 KUD=(AS(I)*FS+PV)/(K1*K3*FDC)
35520 IF(KUD.GT.HS)PRINT,*KUD IS GREATER THAN HS*
35530 MU(I)=AS(I)*FS*(D(I)-K2*KUD)+PV*(0.5*HS-K2*KUD+E(I))
35550 RETURN
35560C
35565C  SECTION HAS NO REINFORCEMENT
35570 170 KUD=PV/(K1*K3*FDC)
35580 MU(I)=PV*(0.5*HS-K2*KUD+E(I))
35590 RETURN
35600 680 FORMAT(*MU(*,I1,*) =*,F10.1,5X,*FPS =*,F10.1,5X,
35610+    *KUD =*,F10.3)
35620 685 FORMAT(*MU(*,I1,*) =*,F10.1,6X,*FS =*,F10.1,5X,
35630+    *KUD =*,F10.3)
35640 690 FORMAT(*MU(*,I1,*) =*,F10.1)
35650 END
50000 SUBROUTINE TRANS (B,ZLV,ZLH,KRAK,ZKLMP,VL1P,VL2P,VS1P,VS2P)
50030C
50040C  THIS SUBROUTINE DETERMINES LOAD AND MASS TRANSFORMATION FACTORS
50050C  AND DYNAMIC REACTION COEFFICIENTS FOR TWO-WAY RESTRAINED SLABS.
50060C  VALUES CORRESPONDING TO PLASTIC BEHAVIOR ARE USED.
50070C
50080C  LOAD AND MASS TRANSFORMATION FACTORS
50830      IF(KRAK.EQ.1)GOTO 335
50835C
```

```
C: CRACK PATTERN A
      CVS=0.5*B
      CVL=0.5*(1.0-B)
      XP=ZLH*B/3.0
      ZP=ZLV*(1.0-4.0*B/3.0)/(4.0*(1.0-B))
      XBARP=0.5*B*ZLH
      ZBARP=ZLV*(1./24.-B/16.)/(1./8.-B/6.)
      GOTO 390
C: CRACK PATTERN B
 335  CVS=0.5*(1.0-B)
      CVL=0.5*B
      XP=ZLH*(1.0-4.0*B/3.0)/(4.0*(1.0-B))
      ZP=ZLV*B/3.0
      XBARP=ZLH*(1./24.-B/16.)/(1./8.-B/6.)
      ZBARP=0.5*B*ZLV
C
C: ALL CASES -- PLASTIC RANGE
 390  ZKMP=(1.0-B)/3.0
      ZKLP=0.5-B/3.0
      ZKLMP=ZKMP/ZKLP
C
C
C  DYNAMIC REACTION COEFFICIENTS FOR SHORT (VS) AND LONG (VL) EDGES
C
C: ALL CASES -- PLASTIC RANGE
 460  VS1P=CVS*(1.0-XP/XBARP)
      VS2P=CVS*(XP/XBARP)
      VL1P=CVL*(1.0-ZP/ZBARP)
      VL2P=CVL*(ZP/ZBARP)
      RETURN
      END
      SUBROUTINE RANDOM (IENTRY)
C THIS SUBROUTINE INPUTS MEAN AND STANDARD DEVIATIONS FOR RANDOM
C VARIABLES; GENERATES RANDOM VALUES; CONTROLS REQUIRED
C NUMBER OF CASES TO BE RUN; AND OUTPUTS FINAL RESULTS AND SUMMARY
C
 COMMON KINC,LDTYPE,KRF,KRANE,TIME,I,Y(100),Q,QU,YU,YFAIL,FDC,
+ ZLS,HS,FDY,AREA,ZMASS,ZKLM,VS1,VS2,PSO,PDO,PR,PEXT,PC,TC,TO,
+ PO,DELAY,S,FPC,FY
     COMMON /RAND/ TIMEC
 DIMENSION CHI25(7),CHI975(7),TDIST(7)
C
C VALUES FOR 97.5%  (F=19,24,29,34,39,44,49)
      DATA CHI25/.4688,.5167,.5533,.5825,.6065,.6267,.6440/
      DATA CHI975/1.7295,1.6402,1.5766,1.5284,1.4903,1.4591,1.4331/
      DATA TDIST/2.093,2.064,2.045,2.032,2.022,2.016,2.010/
C
      GOTO(5,50,70),IENTRY
C
C  ENTRY 1:  INITIALIZE RANDOM NUMBER GENERATOR
  5   XDUMMY=XNORM1(-1.0,0.0,1.0)
      PRINT,/,/,*INPUT NRAND*,
      READ,NRAND
      DO 47 I=1,NRAND
      XDUMMY=XNORM1(0.0,0.0,1.0)
 47   CONTINUE
      INDEX=0$  SPSO=0$  SSPSO=0
      ICHECK=20
C
C  INPUT MEAN AND STANDARD DEVIATION FOR RANDOM VARIABLES
      IF(KRF.EQ.0)GOTO 30
      PRINT 87
      READ,SMEAN,SSD
C  REINFORCED CONCRETE SLABS
 30   PRINT 86
      READ,FYMEAN,FYSD
      PRINT 85
      READ,FPCMEAN,FPCSD
      IF(KRF.EQ.1)PRINT 96
      IF(KRF.EQ.0)PRINT 97
      RETURN
C
C  ENTRY 2:  GENERATE RANDOM VALUES
 50   FY=XNORM1(0.0,FYMEAN,FYSD)
```

```
      IF(FY.LE.0)GOTO 50
 55   FPC=XNORM1(0.0,FPCMEAN,FPCSD)
      IF(FPC.LE.0)GOTO 55
      IF(KRF.EQ.0)GOTO 65
 60   S=XNORM1(0.0,SMEAN,SSD)
      IF(S.LE.0)GOTO 60
 65   INDEX=INDEX+1
      RETURN
C
C  ENTRY 3:  SUM VALUES OF PSO AND PSO**2 FOR USE IN
C            STATISTICAL ANALYSIS
 70   SPSO=SPSO+PSO
      SSPSO=SSPSO+PSO*PSO
C
C OUTPUT FINAL RESULTS
 76   IF(KRF.EQ.1)PRINT 92,FDY,FDC,S,PSO,TIMEC
      IF(KRF.EQ.0)PRINT 90,FDY,FDC,PSO,TIMEC
 80   IF(INDEX.LT.ICHECK)RETURN
C
C DETERMINE MEAN, STANDARD DEVIATION, AND STANDARD ERROR FOR PSO
      ZNO=INDEX
      ZMEAN=SPSO/ZNO
      SD=SQRT((SSPSO-ZNO*ZMEAN*ZMEAN)/ZNO-1)
      STDERR=SD/(SQRT(ZNO-1))
C CHECK IF MAXIMUM OF 50 PSO SAMPLES OBTAINED
      IF(INDEX.EQ.50)GOTO 62
C CHECK IF 95% CONFIDENCE INTERVAL FOR MEAN PSO VALUE IS
      IF(STDERR*TDIST((INDEX-15)/5)/ZMEAN).GT.0.10)GOTO 61
C
C CONFIDENCE INTERVAL IS WITHIN 10% -- DETERMINE UPPER LIMIT OF
C 95% CONFIDENCE INTERVAL FOR STANDARD DEVIATION
C PROBABILITY VALUE AND ITS 95% CONFIDENCE INTERVAL UPPER LIMIT
  62 SDU=SD/(SQRT(CHI25((INDEX-15)/5)))
C CHECK IF MAXIMUM OF 50 PSO SAMPLES OBTAINED
      IF(INDEX.EQ.50)GOTO 53
C CHECK IF UPPER VALUE OF 95% CONFIDENCE INTERVAL FOR STANDARD
C DEVIATION IS WITHIN 0.10*MEAN OF THE STANDARD DEVIATION
      IF(((SDU-SD)/ZMEAN).GT.0.10)GOTO 61
C
C 95% CONFIDENCE INTERVAL IS WITHIN 10% FOR BOTH MEAN AND 90%
C PROBABILITY VALUE -- THEREFORE SUFFICIENT SAMPLES OBTAINED
C DETERMINE 95% CONFIDENCE INTERVALS FOR MEAN, STANDARD DEVIATION
,
C AND 10% AND 90% PROBABILITY VALUES
  53 ZMEANL=ZMEAN-STDERR*TDIST((INDEX-15)/5)
      ZMEANU=ZMEAN+STDERR*TDIST((INDEX-15)/5)
      SDL=SD/(SQRT(CHI975((INDEX-15)/5)))
      P10=ZMEAN-1.282*SD
      P10L=ZMEAN-1.282*SDU
      P10U=ZMEAN-1.282*SDL
      P90=ZMEAN+1.282*SD
      P90L=ZMEAN+1.282*SDL
      P90=ZMEAN+1.282*SD
      P90U=ZMEAN+1.282*SDU
      P90U=ZMEAN+1.282*SDU
C
C OUTPUT STATISTICAL PARAMETERS OF INCIPIENT COLLAPSE PRESSURE
      PRINT 100,ZMEAN,ZMEANL,ZMEANU,SD,SDL,SDU,P10,P10L,P10U,
+       P90,P90L,P90U
      PRINT 105,INDEX,STDERR
      GOTO 999
C
C 95% CONFIDENCE INTERVAL IS NOT WITHIN 10% FOR BOTH MEAN AND 90
B
C VALUES -- THEREFORE OBTAIN 5 ADDITIONAL SAMPLES
  61 ICHECK=ICHECK+5
      RETURN
C
 85 FORMAT(/*INPUT MEAN AND STANDARD DEVIATION FOR F'C*,:)
 86 FORMAT(/*INPUT MEAN AND STANDARD DEVIATION FOR FY*,:)
 87 FORMAT(/*INPUT MEAN AND STANDARD DEVIATION FOR S*,:)
 90 FORMAT(2F9.1,F10.2,F14.3)
 92 FORMAT(2F9.1,F11.2,F10.2,F14.3)
 96 FORMAT(///,5X,*FDY*,6X,*FDC*,8X,*S*,8X,*PSO*,6X,
```

```
      *COLLAPSE TIME*)
 97 FORMAT(///,4X,*FDY*,6X,*FDC*,8X,*PSO*,5X,*COLLAPSE TIME*)
 100 FORMAT(///,11X,*STATISTICAL PROPERTIES OF INCIPIENT PSO*,
      //,39X,*95% CONFIDENCE LIMITS*,/,7X,*ITEM*,18X,
      *VALUE        LOWER        UPPER*,//,* MEAN*,F29.2,
      2F12.2,//,* STANDARD DEVIATION*,F15.2,2F12.2,//,
      * 10% PROBABILITY VALUE*,3F12.2,//,
      * 90% PROBABILITY VALUE*,3F12.2)
 105 FORMAT(//,5X,*NUMBER OF OBSERVATIONS =*,I3,/,5X,
      *STANDARD ERROR =*,F5.2)
 999 STOP$ END
FUNCTION XNORM1(X,A,B)
IF(X)10,20,20
10 XO=RANF(-1.0)
20 X1=RANF(0.0)
X2=RANF(0.0)
Y=SQRT(-2.0*ALOG(X1))*(COS(6.283184*X2))
XNORM1=A+Y*B
RETURN
END
```

RCBEAM

Reinforced Concrete Support Beam

PROGRAM RCBEAM

```
PROGRAM RCBEAM1(INPUT,OUTPUT,TAPE1)
CALL RETR(7HRCBEAM2,7HRCBEAM2)
C * THIS PORTION OF THE PROGRAM INPUTS THE REQUIRED ELEMENT
C:  AND LOAD DATA AND INITIALIZES CERTAIN PARAMETERS *
C
COMMON KINC,LDTYPE,KRF,KRAND,TIME,I,X(100),QT,QU,YU,YFAIL,
+  ZLB,BB,HB,FPC,FDY,ICASE,AS(4),APS(4),D(4),DP(4),FDC,
+  EC,ES,QAREA,PAREA,ZMASS,ZKLM,VL1,VL2,
+  MEMB,ASCS,VCL,QDLSLAB,KCOMP,HS,BS,NSLABS,NAMEF(2),KLOAD,
+  W,PO,CO,LOC,S,ZLEN,CD,PSO,PDO,PR,PEXT,PC,TC,TO,DELAY,
+  TT(80,2),PP(80,2),REAC(80,2),INDEX(2),BR(2),
+  NWIN,RHOO,V3,L1,AA(8,2),NN(8),AFRONT,ASIDE,G,G2,G3,G4,PP2,OT
LOGICAL L1
C
C * READ TITLE AND CONTROL PARAMETERS
PRINT 67
READ 68,TITLE
PRINT 720
READ,NSLABS,KLOAD
PAREA=0
IF(KLOAD.EQ.0)GOTO 40
C
C:  INPUT SLAB REACTION DATA FILE DATA
PRINT 725
DO 39 J=1,NSLABS
PRINT 735,J
READ,NAMEF(J),ISIDE
CALL PFUR(3HREL,1,NAMEF(J))
IF(ISIDE.EQ.1)READ(1,)SAREA,DUM,HS
IF(ISIDE.EQ.2)READ(1,)DUM,SAREA,HS
510 INDEX(J)=1
READ(1,)NPOINT
IF(ISIDE.EQ.2)GOTO 520
515 READ(1,)(TT(JJ,J),PP(JJ,J),REAC(JJ,J),DUM,JJ=1,NPOINT)
GOTO 525
520 READ(1,)(TT(JJ,J),PP(JJ,J),DUM,REAC(JJ,J),JJ=1,NPOINT)
525 BR(J)=(REAC(2,J)-REAC(1,J))/(TT(2,J)-TT(1,J))
BP=(PP(2,J)-PP(1,J))/(TT(2,J)-TT(1,J))
REWIND 1
CALL DROP1(1)
QDLSLAB=QDLSLAB+150.0*SAREA*HS/1728.0
39 PAREA=PAREA+SAREA
KINC=0 $ LDTYPE=5 $ KRF=0 $ KRAND=0
GOTO 45
C
C INPUT TRIBUTARY SLAB DATA
40 PRINT 730
DO 42 J=1,NSLABS
PRINT 735,J
READ,SAREA,HS
QDLSLAB=QDLSLAB+150.0*SAREA*HS/12.0
42 PAREA=PAREA+SAREA*144.0
C
PRINT 85
READ,KINC,LDTYPE,KRF,KRAND
45 CONTINUE
DELAY=0
67 FORMAT(/*INPUT TITLE*,+)
68 FORMAT(A59)
85 FORMAT(/*INPUT KINC,LDTYPE,KRF,KRAND(1=RANDOM)*,+)
720 FORMAT(/*INPUT NUMBER OF SLABS SUPPORTED BY BEAM, AND IF *,
+     *SLAB REACTIONS*/*ARE TO BE CALCULATED (0) OR READ FROM *,
+     *DATA FILE (1)*,+)
725 FORMAT(/*INPUT REACTION DATA FILE NAME AND SIDE *,
+     *(1=SHORT,2=LONG)*)
730 FORMAT(/*INPUT CONTRIBUTARY AREA (SQ FT) AND THICKNESS (IN.)*)
735 FORMAT(6X,*FOR SLAB NO.*,I2,+)
C
C * INPUT AND ECHO BEAM AND REINFORCEMENT PROPERTIES *
PRINT 615
READ,ZLB,BB,HB,FPC,FDY,ICASE,KCOMP
ICASE4=ICASE-4
FDC=1.25*FPC
EC=57619.0*SQRT(FPC)
```

PROGRAM RCBEAM (CONTINUED)

```
ES=29E6
QAREA=ZLB*BB
PAREA=PAREA+QAREA
ECKIP=EC/1000.0 $ ESKIP=ES/1000.0
11 PRINT 670
DØ 8 I=1,3,2
AS(I)=0
IF(ICASE.EQ.5.AND.I.GT.1)GØTØ 8
PRINT 625,I
READ,AS(I),D(I),APS(I),DP(I)
8 CØNTINUE
IF(KCØMP.EQ.0)GØTØ 9
PRINT 616
READ,SP,HS,ASSLAB,DSLAB
BS=0.25*ZLB
IF(BS.GT.(BB+16.0*HS))BS=BB+16.0*HS
IF(BS.GT.SP)BS=SP
9 PRINT 711
READ,MEMB
IF(MEMB.NE.1)GØTØ 15
13 PRINT 705
READ,ASCS
15 CØNTINUE
PRINT 620,ICASE,ZLB,BB,HB,FPC,FDC,ECKIP,FDY,ESKIP
IF(KCØMP.NE.0)PRINT 621,HS,BS,SP
PRINT 630
DØ 110 I=1,3,2
IF(ICASE.EQ.5.AND.I.GT.1)GØTØ 110
P=AS(I)/(BB*D(I)) $ PPR=APS(I)/(BB*D(I))
PRINT 640,I,AS(I),P,D(I),APS(I),PPR,DP(I)
110 CØNTINUE
IF(KCØMP.EQ.0)GØTØ 115
PRINT 641,ASSLAB,DSLAB
IF(ASSLAB.EQ.0)GØTØ 115
ASSLAB=BS*ASSLAB/12.0
DP(1)=(APS(1)*DP(1)+ASSLAB*DSLAB)/(APS(1)+ASSLAB)
APS(1)=APS(1)+ASSLAB
115 ZMASS=150.0*ZLB*HB*BB/(386.07*1728.0)
VCL=2.28*SQRT(FPC)/(1-2*D(1)/ZLB)+3000*(AS(1)/(BB*D(1)))/(1-D(1)/ZLB)
VCLMAX-3.5*SQRT(FPC)/(1.0-2.0*D(1)/ZLB)
IF(VCL.GT.VCLMAX)VCL=VCLMAX
PRINT 685,VCL
C
615 FØRMAT(/*INPUT LB,BB,HB,FPC,FDY,ICASE,KCØMP*,+)
616 FØRMAT(/*INPUT BEAM SPACING, HS, AS(SLAB), & D(SLAB)*,+)
625 FØRMAT(*INPUT AS,D,A'S,&D' FØR SECTIØN*,I2,+)
620 FØRMAT(//*PRØPERTIES ØF REINFØRCED CØNCRETE SUPPØRT BEAM --*,
      * SUPPØRT TYPE NØ.*,I2,/,
      *  LB =*,F6.1,* IN.      BB =*,F6.1,* IN.*,6X,*HB =*,
      F6.1,* IN.*,/,* F'C =*,F7.1,* PSI    FDC =*,F7.1,
      * PSI*,5X,*EC =*,F7.1,* KSI*,/,* FDY =*,F8.1,* PSI*,
      3X,*ES =*,F8.1,* KSI*)
630 FØRMAT(//*REINFØRCEMENT VALUES*/* SECTIØN     AS      (P)*,
   9X,*D*,8X,*A'S     (P')*,4X,*D'*/9X,*(SQ IN.)*,12X,
   *(IN.)    (SQ IN.)*,12X,*(IN.)*)
670 FØRMAT(1H )
685 FØRMAT(/,*VCL =*,F6.1,* PSI*)
705 FØRMAT(/*INPUT CØNTINUØUS REINFØRCEMENT (SQ IN.)*,+)
711 FØRMAT(/*IS TENSILE MEMBRANE TØ BE INCLUDED (0=NØ)*,
    *1=YES)*,+)
640 FØRMAT(I5,F11.4,* (*,F6.4,*)*,F9.3,F10.4,* (*,F6.4,*)*,F9.3)
621 FØRMAT(*  HS =*,F6.1,* IN.      BS =*,F5.1,* IN.*,
    5X,*BEAM SPACING =*,F6.1,* IN.*)
641 FØRMAT(*  SLAB*,F10.4,* SQ IN./FT*,F9.3)
C
C  INPUT LØAD PARAMETERS
IF(LØTYPE.EQ.5)GØTØ 20
C  LØCATIØN 1.  FRØNT FACE LØADING (USED IN RØØM-FILLING PRØCEDURE)
IF(KLØAD.EQ.1)GØTØ 25
100 W=1000.0 $ P3=14.7 $ C3=1120.0
IF(KRF.NE.1)GØTØ 102
LØC=1
IF(KRAND.EQ.1)GØTØ 106
PRINT 600
```

PROGRAM RCBEAM (CONTINUED)

```
READ,S
GØTØ 103
C  LØCATIØN 2. TØP FACE LØADING
102 CD=0 $ LØC=2
ZLEN=ZLB/12.0
105 IF(KINC.EQ.1)GØTØ 106
PRINT 610
READ,PSØ
PR=2.0*PSØ*(7.0*PØ+4.0*PSØ)/(7.0*PØ+PSØ)
600 FØRMAT(/*INPUT S*,+)
610 FØRMAT(/*INPUT PSØ*,+)
C
C * INPUT RØØM-FILLING PARAMETERS *
106 IF(KRF.EQ.0)GØTØ 20
10 PRINT 700
RHØØ=0.076 $ L1=.FALSE.
DELAY=1E10
READ,NWIN,V3
AT=0$ AFRØNT=0$ ASIDE=0
DØ 18 I=1,NWIN
PRINT 710,I
READ,AA(I,1),NN(I),AA(I,2)
AA(I,2)=AA(I,2)/1000.0
AT=AT+AA(I,1)
M=NN(I)$ GØTØ(12,14,14),M
12 AFRØNT=AFRØNT+AA(I,1)
GØTØ 18
14 ASIDE=ASIDE+AA(I,1)
18 IF(AA(I,2).LT.DELAY)DELAY=AA(I,2)
AFRØNT=AFRØNT/AT$ ASIDE=ASIDE/AT
700 FØRMAT(/*INPUT NWIN AND RØØM VØLUME (CF)*,+)
710 FØRMAT(/*INPUT AREA (SQ FT),LØCATIØN CØDE & DELAY(MSEC)*
+     * FØR WINDØW*,I2,+)
G=1.4 $ G2=1./G $ G3=1.-G2 $ G4=2./G3 $ G5=G+1.
PP2=.1912
C=SQRT(G*PØ*32.*144./RHØØ)
TAU=2.*(V3**(1./3.))/C
DT=TAU/4.0
C
20 CØNTINUE
25 CALL CHAIN(RCBEAM2)
99 STØP
END
SEGMENT RCBEAM2 (INPUT,ØUTPUT,TAPE1)
C  THIS SEGMENT CALCULATES THE RESISTANCE FUNCTIØN AND
C  LØADING AND SØLVES THE DYNAMIC EQUATIØNS ØF MØTIØN
C
CØMMØN KINC,LDTYPE,KRF,KRAND,TIME,I,Y(100),QT,QU,YU,YFAIL,
+  ZLB,BB,HB,FPC,FDY,ICASE,AS(4),APS(4),D(4),DP(4),FDC,
+  EC,ES,QAREA,PAREA,ZMASS,ZKL4,VL1,VL2,
+  MSMR,ASCS,VCL,QSLSLAB,KCØMP,HS,BS,NSLABS,NAMEF(2),KLØAD,
+  A,PØ,CØ,LØC,S,ZLEN,CD,PSØ,PDØ,PT,PEXT,PC,TC,TO,DELAY,
+  TT(80,2),PP(80,2),REAC(80,2),INDEX(2),BR(2),
+  NWIN,RHØØ,V3,L1,AA(8,2),NN(8),AFRØNT,ASIDE,G,G2,G3,G4,PP2,DT
CØMMØN /RAND/ TIMEC
DIMENSIØN A(80),V(80),T(80),VS(80),VL(80),PV(80)
C
IF(KINC.NE.1.ØR.LDTYPE.EQ.3)CALL FØRCE(1)
14   IF(KRAND.NE.1)GØTØ 35
     CALL FØRCE(4)
     CALL RANDØM(1)
34   CALL RANDØM(2)
35   CALL RESIST(J)
C
C: MINIMUM, MAXIMUM, AND STARTING VALUES ARE DETERMIN   FØR CASES
C: WHERE THE LØAD CAUSING INCIPIENT CØLLAPSE IS TØ BE FØUND
13   IF(KINC.EQ.0)GØTØ 23
PF=4.0
      PFMAX=0
     PFMIN=0
     GØTØ 20
15    PF=(PFMIN+PFMAX)/2.0
20   CALL FØRCE(2)
23   IF(KRF.EQ.0)GØTØ 24
```

PROGRAM RCBEAM (CONTINUED)

```
01420        CALL FILL(PINT,2)
01430C
01440C:  INITIALIZE VALUES FØR BETA METHØD (BETA=1/6) AND CØMPUTE VALUES
01450C:  FØR FIRST TIME INTERVAL ASSUMING ELEMENT INITIALLY AT REST
01460 24      I=1
01470         TIME=0
01480        V(1)=0 $ Y(1)=0
01490         DELTA=0.001
01500        IF(KRF.NE.1)GØTØ 30
01510 27     IF(TIME.GE.(DELAY-.00001))GØTØ 30
01520        TIME=TIME+DELTA
01530        CALL FILL(PINT,3)
01540        GØTØ 27
01640 30     CALL RESIST(2)
01650        A(1)=0.0 $ VS(1)=0.0 $ VL(1)=0.0
01660        T(1)=TIME
01680C
01690C: PRØCEDURE FØR ALL SUBSEQUENT TIME INTERVALS
01700 1       I=I+1
01710        IF(I.LT.101)GØTØ 11
01720        PRINT 98,TIME
01730 98 FØRMAT(/I=101: TIME =*,F6.3,*: FAILURE ASSUMED TØ NØT ØCCUR*)
01740        GØTØ 6
01750 11     TIME=TIME+DELTA
01760         T(I)=TIME
01770         A(I)=A(I-1)
01775        IF(KRF.NE.0)GØTØ 10
01780        CALL FØRCE(3)
01790        PN(I)=PEXT
01800        GØTØ 2
018080 DIMENSIØN A(100),V(100),T(100),VL(100),PN(100)
01880 10     CALL FILL(PINT,3)
01890        PN(I)=PINT
01910 2 IF(KLØAD.EQ.0)PT=PN(I)*PAREA
01915 IF(KLØAD.NE.0)PT=PN(I)
01920        DØ 8 JJ=1,10
01930         Y(I)=Y(I-1)+DELTA*V(I-1)+DELTA*DELTA*(A(I-1)/3.+A(I)/6.)
01940         CALL RESIST(2)
01960 4 ANEW=(PT-QT)/(ZMASS*ZKLM)
01970         ADELTA=ANEW-A(I)
01980         A(I)=ANEW
01985 IF(ANEW.EQ.0)PRINT,*1985*,TIME,PT,QT,ZMASS,ZKLM,Y(I),A(I-1)
01990        IF(ABS(ADELTA/(ANEW+1E-10)).LT.0.01)GØTØ 9
02000 8       CØNTINUE
02010         A(I)=ANEW-ADELTA/2.0
02020 PRINT 80,TIME,PF,A(I),Y(I)
02030 9       CØNTINUE
02040         Y(I)=Y(I-1)+DELTA*V(I-1)+DELTA*DELTA*(A(I-1)/3.+A(I)/6.)
02050         V(I)=V(I-1)+DELTA*(A(I)+A(I-1))/2.0
02070 VL(I)=VL1*PT+VL2*QT
02090C
02100C: CHECK FØR MAXIMUM DEFLECTIØN ØR FAILURE
02110C:    IF MAXIMUM DEFLECTIØN REACHED, WALL DID NØT FAIL
02120         IF(Y(I).LE.Y(I-1).AND.PN(I).LE.PN(I-1))GØTØ 6
02130         IF(Y(I).LT.0)GØTØ 6
02135         IF(Y(I).GE.YFAIL)GØTØ 7
02140         IF(TIME-DELAY.GE.0.010)DELTA=0.002
02160         IF(TIME-DELAY.GE.0.020)DELTA=0.005
02170         IF(TIME-DELAY.GE.0.100)DELTA=0.010
02180         IF(TIME-DELAY.GE.0.500)DELTA=0.050
02190C:    IF FAILURE DEFLECTIØN REACHED, ELEMENT FAILED
02210          GØTØ 1
02220C
02230C: INTERVAL HALVING PRØCEDURE TØ DETERMINE LØAD CAUSING INCIPIENT
02240C: CØLLAPSE FØR CASES WHERE DESIRED
02250C:    ELEMENT DID NØT FAIL -- SET PFMIN TØ PF
02260 6       CØNTINUE
02280         IF(KINC.EQ.0)GØTØ 18
02290 36     PFMIN=PF
02300 IF(PFMAX.GT.0)GØTØ 16
02310         PF=2.0*PF
02320         GØTØ 20
02330C:    ELEMENT FAILED -- SET PFMAX TØ PF
02340 7       CØNTINUE
```

PROGRAM RCBEAM (CONTINUED)

```
02350       TIMEC=TIME
02370       IF(KINC.EQ.0)GØTØ 18
02380 37    PFMAX=PF
02390C:   CHECK TØ SEE IF LØAD RANGE IS WITHIN DESIRED ACCURACY
02400 17    IF((PFMAX-PFMIN)/PFMAX.GT.0.01)GØTØ 16
02410       IF(KRAND.NE.1)GØTØ 18
02420       CALL RANDØM(3)
02430       GØTØ 34
02440C
02450C: ØUTPUT DATA INCLUDES THE MAXIMUM DEFLECTIØN AND TIME ØF
02460C: ØCCURANCE FØR A NØN-FAILING ELEMENT ØR THE TIME AND VELØCITY
02470C: AT CØLLAPSE FØR A FAILING ELEMENT.  ØPTIØNAL ØUTPUT IS THE
02480C: ENTIRE BEHAVIØR TIME-HISTØRY.
02490C
02500C: ØUTPUT LØAD DATA
02510 18      ALL FØRCE(4)
02520C
02530C: ØUTPUT FINAL RESULTS
02540 IF(Y(I).LT.YFAIL)PRINT 70,Y(I),T(I)
02550 IF(Y(I).GE.YFAIL)PRINT 71,T(I),V(I)
02577C
02578C CHECK TØ SEE IF ENTIRE TIME-HISTØRY IS DESIRED
02580 PRINT 72
02590 READ,M
02600         IF(M.EQ.0)GØTØ 25
02680 PRINT 76,(T(J),PN(J),A(J),V(J),Y(J),VL(J),J=1,I)
02690 25 PRINT 77
02710C
02740 70 FØRMAT(/*NØ FAILURE - MAX DEFLECTIØN ØF*,F6.2,
02750+     * IN. REACHED AT*F7.3,* SEC*)
02760 71 FØRMAT(/*FAILURE ØCCURRED AT*,F7.3,* SEC (FINAL VELØCITY =*,
02770+   F7.2* IN./SEC)*)
02780 72 FØRMAT(/*IS TIME HISTØRY DESIRED (YES=1, NØ=0)*,*)
02830 76 FØRMAT(/*  TIME  PRESSURE  ACCELERATIØN  VELØCITY  *
02840+   *DISPLACEMENT    VL*,/,
02850+   (F6.3,F9.3,F12.1,F12.2,F12.4,F11.0))
02860 77    FØRMAT(///,7(*----------*))
02870 80 FØRMAT(/*ACCELERATIØN NØT CØNVERGING AT TIME =*,F6.3,
02880+           * SEC (PF =*,F7.3,* PSI)*/*     A(I) SET EQUAL TØ*,
02890+           F8.1,* (AVG ØF LAST 2 ITERATIØNS)*/*     Y(I) =*,
02900+           F8.4,* IN.*)
02950C
02960 999    STØP
02970       END
10000 SUBRØUTINE FØRCE(IENTRY)
10010C  THIS SUBRØUTINE INPUTS THE LØAD PARAMETERS AND DETERMINES
10020C  THE LØAD AT A GIVEN TIME FØR THE FØLLØWING LØAD TYPES:
10030C      1. IDEALIZED BLAST LØAD (FRØNT ØR SIDE FACE)
10050 CØMMØN KINC,LDTYPE,KRF,KRAND,TIME,I,Y(100),QT,QU,YU,YFAIL,
10052+   ZLB,BB,HB,FPC,FDY,ICASE,AS(4),APS(4),D(4),DP(4),FDC,
10054+   EC,ES,QAREA,PAREA,ZMASS,ZKLM,VL1,VL2,
10055+   MEMB,ASCS,VCL,QOLSLAB,KCØMP,HS,BS,NSLABS,NAMEF(2),KLØAD,
10056+   W,PØ,CØ,LØC,S,ZLEV,CD,PSØ,PDØ,PR,P,PC,TC,TO,DELAY,
10057+   TT(80,2),PP(80,2,,REAC(80,2),INDEX(2),BR(2),
10058+   NWIN,RHØØ,V3,L1,AA(8,2),NN(8),AFRØNT,ASIDE,G,G2,G3,G4,PP2,DT
10080C
10130 IF(LDTYPE.EQ.5)GØTØ 700
10135 IF(KLØAD.EQ.1)GØTØ 500
10140C
10150 GØTØ(215,200,300,4),IENTRY
11000C
11010C  CALCULATE LØAD PRØPERTIES FØR GIVEN PEAK PRESSURE
11030 200 GØTØ(205,210),LØC
11040 205 PSØ=(PR-14.0*PØ+SQRT(196.0*PØ*PØ+196.0*PØ*PR+PR*PR))/16.0
11050 GØTØ 215
11060 210 PSØ=PR
11070 215 PDØ=2.5*PSØ*PSØ/(7.0*PØ+PSØ)
11080 U=CØ*SQRT(1.0+(6.0*PSØ)/(7.0*PØ))
11090 TO=W**0.3333/(2.2399+0.1886*PSØ)
11100 GØTØ(220,225),LØC
11110 220 TC=3.0*S/U
11120 PC=PSØ*(1-TC/TO)*EXP(-TC/TO)+PDØ*(1-TC/TO)**2*EXP(-2*TC/TO)
11130 CD=1.0
11140 RETURN
```

```
11150 225 TA=ZLEN/U
11160 TA2=TA/2.0
11170 TA2TO=TA2/TO
11180 PA=PSØ*(1-TA2TO)*EXP(-TA2TO)+CD*PDØ*(1-TA2TO)**2*EXP(-2*TA2TO)
11190 RETURN
12000C
12010C  CALCULATE LØAD
12030 300 GØTØ(305,310),LØC
12040 305 TTO=TIME/TO
12050 IF(TIME.GT.TC)GØTØ 320
12060 P=PC+(TC-TIME)*(PR-PC)/TC
12070 RETURN
12080 310 TTO=(TIME-TA2)/TO
12090 IF(TIME.GT.TA)GØTØ 320
12100 P=PA*TIME/TA
12110 RETURN
12120 320 IF(TTO.GE.1.0)GØTØ 330
12130 P=PSØ*(1-TTO)*EXP(-TTO)+CD*PDØ*(1-TTO)**2*EXP(-2*TTO)
12150 RETURN
12160 330 P=0
12170 RETURN
13000C
13010C  PRINT LØAD DATA
13020 4 IF(KINC.EQ.0)GØTØ 400
13030 PRINT 640,LDTYPE
13040 GØTØ 410
13050 400 PRINT 645,LDTYPE
13060 410 CØNTINUE
13070 415 GØTØ(420,425),LØC
13080 420 PRINT 650
13090 GØTØ 430
13100 425 PRINT 655
13110 430 PRINT 660,W,PØ,CØ
13120 IF(KRAND.NE.0)RETURN
13130 GØTØ(435,440),LØC
13140 435 PRINT 665,S,TC,PR
13150 GØTØ 445
13160 440 PRINT 670,ZLEN,TA,PA
13170 445 PRINT 675,U,TO,CD,PSØ,PDØ
13180 RETURN
13500C
13510C  LØAD TYPE 5 -- ARBITRARY LØAD SHAPE
13520 700 GØTØ(710,720,730,740),IENTRY
13530C
13540C  INPUT LØAD DATA
13550 710 PRINT 750
13560 READ,NPØINT,(TT(J,1),PP(J,1),J=1,NPØINT)
13570 FACTØR=1.0
13580 IF(KINC.EQ.0)GØTØ 718
13590 PMAX=PP(1,1)
13600 DØ 715 J=2,NPØINT
13610 715 IF(PP(J,1).GT.PMAX)PMAX=PP(J,1)
13620 718 PX=PP(2,1)-PP(1,1)
13630 TX=TT(2,1)-TT(1,1)
13640 JJ=1
13650 RETURN
13660C
13670C  CALCULATE MAXIMUM LØAD
13680 720 FACTØR=PR/PMAX
13690 GØTØ 718
13700 RETURN
13710C
13720C  CALCULATE LØAD
13730 730 IF(TIME.LE.TT(JJ+1,1))GØTØ 735
13740 JJ=JJ+1
13750 PX=PP(JJ+1,1)-PP(JJ,1)
13760 TX=TT(JJ+1,1)-TT(JJ)
13765 IF(TX.EQ.0)TX=1E-10
13770 GØTØ 730
13780 735 P=FACTØR*(PP(JJ,1)+(TIME-TT(JJ,1))*PX/TX)
13790 RETURN
13800C
13810C  PRINT LØAD DATA
13815 740 IF(KINC.EQ.1)PRINT 640,LDTYPE
```

PROGRAM RCBEAM (CONTINUED)

```
13820 IF(KINC.EQ.0)PRINT 645,LDTYPE
13825 PRINT 790
13830 DØ 745 J=1,NPØINT
13840 P=FACTØR*PP(J,1)
13850 745 PRINT 795,TT(J,1),P
13860 RETURN
14000C
14070 640 FØRMAT(/*LØAD CAUSING INCIPIENT FAILURE IS AS FØLLØWS:*,
14071+      /,5X,*LØAD TYPE NUMBER*,I2)
14080 645 FØRMAT(/*PRØPERTIES ØF LØAD ACTING ØN WALL ARE AS FØLLØWS:*,
14081+      /,5X,*LØAD TYPE NUMBER*,I2)
14090 650 FØRMAT(8X,*(FRØNT FACE)*)
14100 655 FØRMAT(5X,*(SIDE ØR TØP FACE)*)
14110 660 FØRMAT(10X,*W =*,F8.1,* KT    PØ =*,F6.2,* PSI      CO =*,
14111+      F7.1,* FPS*)
14120 665 FØRMAT(10X,*S =*,F6.1,* FT      TC =*,F6.3,* SEC      PR =*,
14121+      F7.3,* PSI*)
14130 670 FØRMAT(10X,*L =*,F6.1,* FT      TA =*,F6.3,* SEC      PA =*,
14131+      F7.3,* PSI*)
14140 675 FØRMAT(10X,*U =*,F7.1,* FPS    TO =*,F6.3,* SEC      CD =*,
14141+      F5.1,/,8X,*PSØ =*,F7.3,* PSI  PDØ =*,F7.3,* PSI*)
14150 780 FØRMAT(/*INPUT NUMBER ØF LØAD PØINTS AND THE TIME AND *
14151+      *PRESSURE AT EACH PØINT*)
14160 790 FØRMAT(/10X,*TIME       PRESSURE*)
14170 795 FØRMAT(F15.3,F12.2)
15000C
15002C:   SLAB REACTIØN DATA
15010 500 GØTØ(510,530,540,560),IENTRY
15020 510 RETURN
15085C
15090 530 STØP
15095C
15100 540 P=0.0
15110 DØ 555 J=1,NSLABS
15115 545 JJ=INDEX(J)
15120 550 IF(TIME.LE.TT(JJ+1,J))GØTØ 555
15125 INDEX(J)=INDEX(J)+1 $ JJ=INDEX(J)
15130 IF(JJ.LT.NPØINT)GØTØ 552
15132 PRINT 690,TIME
15133 STØP
15135 552 BR(J)=(REAC(JJ+1,J)-REAC(JJ,J))/(TT(JJ+1,J)-TT(JJ,J))
15140 BP=(PP(JJ+1,J)-PP(JJ,J))/(TT(JJ+1,J)-TT(JJ,J))
15150 GØTØ 550
15160 555 P=P+REAC(JJ,J)+(TIME-TT(JJ,J))*BR(J)
15165 P=P+QAREA*(PP(JJ,J)+(TIME-TT(JJ,J))*BP)
15170 RETURN
15180 560 PRINT 680
15190 DØ 565 J=1,NSLABS
15200 565 PRINT 685,NAMEF(J)
15300 680 FØRMAT(/*BEAM LØADED WITH REACTIØNS FRØM FILE(S):*)
15310 685 FØRMAT(10X,A7)
15315 690 FØRMAT(/*END ØF FILE -- BEAM HAS NØT FAILED AT*,F6.3,* SEC*)
15320 RETURN
15330 END
20000 SUBRØUTINE FILL(P3,IENTRY)
20010C: CØMPUTES AVERAGE AIR PRESSURE IN RØØM DUE TØ BLAST WAVE
20020C: INCIDENT HEAD-ØN UPØN FRØNT WALL.
20030C
20050 CØMMØN KINC,LDTYPE,KRF,KRAND,TIME,II,Y(100),DT,DU,YU,YFAIL,
20052+   ZLB,BB,HB,FPC,FDY,ICASE,AS(4),APS(4),D(4),DP(4),FDC,
20054+   EC,ES,QAREA,PAREA,ZMASS,ZKLM,VL1,VL2,
20055+   MEMB,ASCS,VCL,QDLSLAB,KCØMP,HS,BS,NSLABS,NAMEF(2),KLØAD,
20056+   W,PØ,CØ,LØC,S,ZLEN,CD,PSØ,PDØ,PR,PEXT,PC,TC,TO,DELAY,
20057+   TT(80,2),PP(80,2),REAC(80,2),INDEX(2),BR(2),
20058+   NWIN,RHØØ,V3,L1,AA(8,2),NN(8),AFRØNT,ASIDE,G,G2,G3,G4,PP2,DT
20090 LØGICAL L1,L2,L3
20095C
20100 GØTØ(10,13,11),IENTRY
20110 10 RETURN
20310C
20320 13 P30=P3
20330 TT=0.$ TØ=0.
20340 RHØ30=RHØØ
20350 L2=.FALSE. $ L3=.FALSE.
```

PROGRAM RCBEAM (CONTINUED)

```
RETURN
C
11 IF(L1)GØTØ 52
IF(L2.A.L3)GØTØ 9
52 DDT=(TIME-T0)*0.5
ISTØP=2
53 IF(DDT.LT.DT)GØTØ 51
50 DDT=0.5*DDT
ISTØP=2*ISTØP
GØ TØ 53
51 CØNTINUE
DØ 99 I=1,ISTØP
TT=T0+I*DDT
IF(TT.GT.TO)GØ TØ 99
DM=0. $ WW=0. $ NW=0
DØ 500 K=1,NWIN
M=NN(K) $ DLY=AA(K,2)+0.000001
IF(DLY.GE.TT)GØ TØ 500
GØTØ(15,16,16),M
15 CDF=1.0
IF(TT-TC)20,20,21
20  P11=(TC-TT)*(PR-PC)/TC+PC
P11=P11+PØ
GØ TØ 30
16 CDF=-0.4
21  R=TT/TO $ RR=1.-R
PD=PDØ*RR*RR*EXP(-2.*R)
PS=PSØ*RR*EXP(-R)
P11=PS+CDF*PD
P11=P11+PØ
30  RHØ1=RHØ3Ø*((P11/P3Ø)**G2)
IF(P11-P3Ø)36,36,37
36  ISIGN=-1
L2=.TRUE.
303  P2=P11
RH32=((P2/P3Ø)**G2)*RHØ3Ø
X=P3Ø/RHØ3Ø
GØ TØ 38
37  ISIGN=+1
306 P2=PP2*P11
RH32=((P2/P11)**G2)*RHØ1
X=P11/RHØ1
38  U22=G4*(X-P2/RH32)*32.*144.
IF(U22)40,39,39
40  PRINT,*U22 NEGATIVE*,U22
STØP
39  U2=SQRT(U22)*ISIGN
DDM=U2*RH32*AA(K,1)*DDT
DM=DM+DDM
WW=WW+P11*DDM/(G3*RHØ1)
C
500 CØNTINUE
P3Ø=P3Ø+(G-1.)*WW/V3
RHØ3Ø=RHØ3Ø+DM/V3
99  CØNTINUE
TØ=TT
P3=P3Ø-PØ
IF(TIME.GE.TC)L3=.TRUE.
RETURN
9 R=TIME/TO $ RR=1.0-R
PD=PDØ*RR*RR*EXP(-2.0*R)
PS=PSØ*RR*EXP(-R)
P3=PS+PD*(AFRØNT-0.4*ASIDE)
999 RETURN
END
SUBRØUTINE RESIST (IENTRY)
C: THIS SUBRØUTINE DETERMINES THE RESISTANCE FUNCTIØN,
C: TRANSFØRMATIØN FACTØRS, AND REACTIØN CØEFFICIENTS; AND
C: SUPPLIES THE REACTIØN VALUES FØR SPECIFIC DEFLECTIØNS
C
CØMMØN KINC,LDTYPE,KRF,KRAND,TIME,I,Y(100),Q,QU,YU,YFAIL,
+  ZL9,BB,H9,FPC,FDY,ICASE,AS(4),APS(4),D(4),DP(4),FDC,
+  EC,ES,QAREA,PAREA,ZMASS,ZKLM,VL1,VL2,
+  MEMB,ASCS,VCL,QDLSLAB,KCØMP,HS,BS,NSLABS,NAMEF(2),KLØAD,
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PROGRAM RCBEAM (CONTINUED)

```
30056+  W,PØ,CØ,LØC,S,ZLEN,CD,PSØ,PDØ,PR,PEXT,PC,TC,TO,DELAY,
30057+  TT(80,2),PP(80,2),REAC(80,2),INDEX(2),BR(2),
30058+  NWIN,RHØØ,V3,L1,AA(8,2),VV(8),AFRØNT,ASIDE,G,G2,G3,G4,PP2,OT
30100 REAL N,IC,IG,MM,KK1,KK2,KK3,MU(4),ICR(4),KT,ICC,ICS
30130 GØTØ(4,500,45),IENTRY
30140 4 RETURN
30810C
30830C * ENTRY 2:  DETERMINE RESISTANCE FUNCTIØN *
30840 45 N=ES/EC
30850 FR=8.0*SQRT(FDC)
30860 IG=BB*HB**3/12.+(N-1)*(AS(1)*(D(1)-HB/2.)**2
30861+     +APS(1)*(HB/2.-DP(1))**2)
30870 MM=2.0*IG*FR/HB
30872 IF(KCØMP.EQ.0)GØTØ 50
30874 YBART=0.5*(HB*HB*BB+HS*HS*(BS-BB))/(HS*(BS-BB)+HB*BB)
30876 IG=IG+(0.5*HB-YBART)**2+HS**3*(BS-BB)/12.0
30877+     +HS*(BS-BB)*(YBART-0.5*HS)**2
30878 MM=IG*FR/(HB-YBART)
30879 50 IF(KCØMP.EQ.0)BS=BB
30880 CALL MØMENT(FDC,FDY,ES,N,0,BS,AS,APS,D,DP,MU,ICR,IC,KCØMP,HS,BB)
31800C: DETERMINE MØMENT AND DEFLECTIØN CØEFFICIENTS
31810C: FØR CRACKED PØRTIØN ØF SLAB BEHAVIØR
31820 106 B=0
31830 ICASE4=ICASE-4
31832 ICC=ICR(1) $ ICS=ICR(3)
31834 CALL CØEF(ICASE4,ASS,BSS,AF,BF,ICC,ICS)
31840 GØTØ(182,185,190),ICASE4
31850 182 OUTERM=1.0/BSS
31860 GØTØ 195
31870 185 OUTERM=(MU(3)/MU(1)+1.0)/BSS
31880 GØTØ 195
31890 190 OUTERM=(0.5*MU(3)/MU(1)+1.0)/BSS
31900 195 GØTØ(200,210,210),ICASE4
31910C
31920C: ****************************************************************
31930C: * DETERMINE RESISTANCE (TØTAL) CURVE FØR WALL                  *
31940C: * (Q IS IN UNITS ØF LB, KK IN LB/IN., AND Y IN INCHES)         *
31950C: ****************************************************************
31960C
31970C: CASE 5
31980 200 Q1=MM/(BSS*ZLB)
31990 KK1=EC*IG/(ASS*ZLB**3)
32000 Y1=Q1/KK1
32010 KK2=EC*ICR(1)/(ASS*ZLB**3)
32050 205 QU=QUTERM*MU(1)/ZLB
32060 208 YU=QU/KK2
32070 GØTØ 280
32080C
32090C: CASES 6 AND 7
32100 210 Q1=MM/(BF*ZLB)
32110 KK1=EC*IG/(AF*ZLB**3)
32120 Y1=Q1/KK1
32130 Q2=MU(3)/(BF*ZLB)
32140 KK2=EC*ICR(3)/(AF*ZLB**3)
32150 Y2=Q2/KK2
32160 KK3=EC*ICR(3)/(ASS*ZLB**3)
32200 215 QU=QUTERM*MU(1)/ZLB
32210 220 YU=Y2+(QU-Q2)/KK3
32220 280 CØNTINUE
32260 QFAIL=QU
32270 YT=999.9
32280C
32290C: CHECK FØR TYPE ØF FAILURE - LIGHTLY REINFØRCED ØR CØNVENTIØNAL
32300 IF(MU(1).LT.1.5*MM)GØTØ 288
32310C
32320C: CØNVENTIØNAL TYPE FAILURE
32322 IF(ICASE.EQ.1.ØR.ICASE.EQ.5)GØTØ 272
32324 YE=Y2+YU*(1.0-Q2/QU)
32326 GØTØ 273
32328 272 YE=YU
32330 273 YFAIL=YE*0.1/(AS(1)/(BB*D(1)))
32340C: DUCTILITY FACTØR MUST BE <= 30
32350 IF(YFAIL.GT.30.0*YE)YFAIL=30.0*YE
32370 GØTØ 300
```

PROGRAM RCBEAM (CONTINUED)

```
C
C: LIGHTLY REINFORCED TYPE OF FAILURE
C:  THE FOLLOWING EXPRESSION IS BASED ON A STEEL ELONGATION OF 20%
 299 UCOEF=30.
 PRINT 605
 READ,NOBAR
 UPU=UCOEF*SQRT(FDC)
 ABAR=3.14159*(NOBAR/16.)**2
 290 YFAIL=SQRT((0.2*ABAR*FDY/UPU+ZLB/2.)**2-(ZLB/2.)**2)
C
C  TENSILE MEMBRANE BEHAVIOR
 300 IF(MEMB.NE.1)GOTO 285
 312 KT=8.0*1.5
 TS=ASCS*FDY
 314 YT=QU*ZLB/(KT*TS)
 QT=QU
 IF(YT.LE.YFAIL)GOTO 316
 YT=YFAIL
 QT=YT*KT*TS/ZLB
 316 IF(YFAIL.LT.0.15*ZLB)YFAIL=0.15*ZLB
 QFAIL=0.15*KT*TS
C ADJUST LOAD-DEFLECTION CURVE FOR BEAM DEAD LOAD
 285 QDL=QDLSLAB+150.0*HB*BB*ZLB/1728.0
 IF(QDL.GT.Q1)GOTO 292
 YDL=QDL/KK1
 GOTO 295
 292 GOTO(293,294,294),ICASE4
 293 YDL=Y1+(QDL-Q1)*(YU-Y1)/(QU-Q1)
 291 IF(QDL.LT.QU)GOTO 295
 PRINT,*QDL =*,QDL,*  QU =*,QU $ STOP
 294 YDL=Y1+(QDL-Q1)*(Y2-Y1)/(Q2-Q1)
 IF(QDL.LT.Q2)GOTO 295
 YDL=Y2+(QDL-Q2)*(YU-Y2)/(QU-Q2) $ GOTO 291
 295 Y1=Y1-YDL$ Y2=Y2-YDL$ YU=YU-YDL$ YT=YT-YDL$ YFAIL=YFAIL-YDL
 Q1=Q1-QDL$ Q2=Q2-QDL$ QU=QU-QDL$ QT=QT-QDL$ QFAIL=QFAIL-QDL
 IF(KRAND.NE.1)PRINT 633,QDL,YDL
C
C: OUTPUT LOAD-DEFLECTION CURVE
 IF(KRAND.EQ.1)GOTO 335
 PRINT 650
 IF(ICASE.EQ.5)GOTO 320
 PRINT 660,Q1,Y1,Q2,Y2
 GOTO 330
 320 PRINT 660,Q1,Y1
 330 IF(MEMB.EQ.1)GOTO 332
 PRINT 660,QU,YU,QFAIL,YFAIL
 GOTO 335
 332 IF(QT.NE.QU)GOTO 333
 PRINT 660,QU,YU,QT,YT,QFAIL,YFAIL
 GOTO 335
 333 PRINT 660,QU,YU,QU,YT,QT,YT,QFAIL,YFAIL
 335 CONTINUE
C
 CALL TRANS(ICASE4,ZKLM,ZKLMSE,ZKLMFE,ZKLMP,VL1S,VL2S,VL1F,
+              VL2F,VL1P,VL2P)
 QSHRL=VCL*D(1)*BB
 340 IF(KRAND.NE.1)PRINT 695,QSHRL
 RETURN
C
C: *******************************************************
C: * ENTRY 3: DETERMINE THE RESISTANCE (PER UNIT AREA) *
C: *           OF THE WALL AS A FUNCTION OF Y(I)        *
C: *******************************************************
C
 500 IF(Y(I).GE.YFAIL)GOTO 560
 IF(Y(I).GT.YU)GOTO 540
 GOTO(501,520,520,520,501,520,520),ICASE
 501 CONTINUE
C
C: ELASTIC RANGE -- CASES 1 AND 5
 ZKLM=ZKLMSE
 VL1=VL1S $ VL2=VL2S
 IF(Y(I).GT.Y1)GOTO 510
C
```

PROGRAM RCBEAM (CONTINUED)

```
C: UNCRACKED PØRTIØN -- ALL CASES
 505 Q=Y(I)*KK1
 RETURN
C
C: CRACKED PØRTIØN -- CASES 1 AND 5
 510 Q=Q1+(Y(I)-Y1)*(QU-Q1)/(YU-Y1)
 RETURN
C
 520 IF(Y(I).GT.Y2)GØTØ 530
C
C: ELASTIC RANGE -- CASES 2,3,4,6,7
 ZKLM=ZKLMFF
 VL1=VL1F $ VL2=VL2F
 IF(Y(I).LT.Y1)GØTØ 505
C: CRACKED PØRTIØN -- CASES 2,3,4,6,7
 Q=Q1+(Y(I)-Y1)*(Q2-Q1)/(Y2-Y1)
 RETURN
C
C: ELASTØ-PLASTIC RANGE -- CASES 2,3,4,6,7
 530 ZKLM=ZKLMSE
 VL1=VL1S $ VL2=VL2S
 Q=Q2+KK3*(Y(I)-Y2)
 RETURN
C
C: PLASTIC RANGE -- ALL CASES
 540 ZKLM=ZKLMP
 VL1=VL1P $ VL2=VL2P
 IF(Y(I).GT.YT)GØTØ 550
 Q=QU
 RETURN
C
C  TENSILE MEMBRANE RANGE -- ALL CASES
 550 Q=QT+(Y(I)-YT)*(QFAIL-QT)/(YFAIL-YT)
 RETURN
C
C: WALL CØLLAPSED - NØ RESISTANCE (TØ AVØID NUMERICAL DIFFICULTIEES
C: FØR CERTAIN CASES SET RESISTANCE EQUAL TØ VERY SMALL VALUE)
 560 Q=1E-10
 RETURN
C
 605 FØRMAT(/*INPUT BAR NUMBER ØF REINFØRCEMENT*,+)
 633 FØRMAT(/*QDL =*,F10.2,* LB    YDL =*,F8.4,* IN.*)
 650 FØRMAT(//*LØAD-DEFLECTIØN CURVE*,/,4X,*QT (LB)       Y (IN.)*)
 660 FØRMAT(F10.2,F12.4)
 695 FØRMAT(/*QSHRL =*,F11.2,* LB*)
 END
 SUBRØUTINE MØMENT(FDC,FDY,ES,N,PV,B,AS,APS,D,DP,MU,ICR,IC,
+                  KCØMP,HS,BP)
C THIS SUBRØUTINE DETERMINES THE ULTIMATE MØMENT CAPACITY AND
C CRACKED MØMENT ØF INERTIA  FØR REQUIRED SECTIØNS
 REAL K1,K2,K3,KUD,N,IC,ICTØT,MU(4),ICR(4),AS(4),APS(4),D(4),DP(4)
C
C: DETERMINE VALUES ØF CØNCRETE PARAMETERS
 45 K1=0.94-FDC/26E3
 K2=0.50-FDC/8E4
 K3=(3900.0+0.35*FDC)/(3E3+0.82*FDC-FDC*FDC/26E3)
 EPSC=0.004-FDC/65E5
C: ************************************************
C: * DETERMINE ULTIMATE MØMENT CAPACITY AND CRACKED *
C: * MØMENT ØF INERTIA FØR REQUIRED SECTIØNS       *
C: ************************************************
C
 II=0$ ICTØT=0
 DØ 170 I=1,4
 IF(AS(I).EQ.0)GØTØ 170
 II=II+1
C: ALL PRØPERTIES ARE CØMPUTED FØR A WIDTH B
 TENS=AS(I)*FDY*PV
 IF(APS(I).LE.0)GØTØ 150
C
C: WALL HAS CØMPRESSIØN REINFØRCEMENT
 C=K1*K3*FDC*B*DP(I)
 TERM1=0.5*(TENS/APS(I)+ES*EPSC)
 TERM2=ES*EPSC*(TENS-C)/APS(I)
```

PROGRAM RCBEAM (CONTINUED)

```
C: DETERMINE LOCATION OF NEUTRAL AXIS
IF(TENS.LE.C)GOTO 140
C
C: KUD > D'
FPS=TERM1+K3*FDC/2.0-SQRT((TERM1+K3*FDC/2.0)**2
+  -(TERM2+ES*EPSC*K3*FDC))
C: F'S MUST BE <= FDY
IF(FPS.LT.FDY)GOTO 130
FPS=FDY
130 TPS=APS(I)*(FPS-K3*FDC)
KUD=(TENS-TPS)/(K1*K3*FDC*B)
MU(I)=(TENS-TPS)*(D(I)-K2*KUD)+TPS*(D(I)-DP(I))
ICR(I)=B*KUD**3/3.0+N*AS(I)*(D(I)-KUD)**2
+  +(N-1)*APS(I)*(KUD-DP(I))**2
GOTO 152
C
C: KUD < D'
140 FPS=-TERM1+SQRT(TERM1**2-TERM2)
C: F'S MUST BE <= FDY
IF(FPS.LT.FDY)GOTO 145
FPS=FDY
145 TERM3=TENS+APS(I)*FPS
KUD=TERM3/(K1*K3*FDC*B)
MU(I)=TERM3*(D(I)-K2*KUD)-APS(I)*FPS*(D(I)-DP(I))
ICR(I)=B*KUD**3/3+N*AS(I)*(D(I)-KUD)**2+N*APS(I)*(DP(I)-KUD)**2
GOTO 152
C
C: WALL HAS NO COMPRESSION REINFORCEMENT
150 KUD=TENS/(K1*K3*FDC*B)
MU(I)=TENS*(D(I)-K2*KUD)
ICR(I)=B*KUD**3/3.0+N*AS(I)*(D(I)-KUD)**2
C
152 IF(KCOMP.EQ.0)GOTO 155
IF(I.EQ.3)GOTO 170
IF(KUD.LT.HS)GOTO 170
C
C * TEE BEAM -- NEUTRAL AXIS OUTSIDE FLANGE *
C   (USE EQUIVALENT RECTANGULAR STRESS BLOCK)
ASF=0.85*FDC*(B-BP)*HS/FDY
KUD=(AS(I)-ASF)*FDY/(0.85*FDC*BP)
MU(I)=ASF*FDY*(D(I)-0.5*HS)+(AS(I)-ASF)*FDY*(D(I)-0.5*KUD)
ICR(I)=BP*KUD**3/3.0+(B-BP)*HS**3/12.0+HS*(B-BP)*(KUD-0.5*HS)**2
+         +N*AS(I)*(D(I)-KUD)**2
155 ICTOT=ICTOT+ICR(I)
170 CONTINUE
C
C: DETERMINE AVERAGE CRACKE    MENT OF INERTIA
175 IC=ICTOT/II
RETURN
END
SUBROUTINE COEF (ICASE4,ASS,BSS,AF,BF,ICEN,ISUP)
C
C  THIS SUBROUTINE DETERMINES DEFLECTION AND MOMENT COEFFICIENTS
C  FOR TEE BEAMS WITH VARIABLE MOMENT OF INERTIA
C
REAL ICEN,ISUP
C:  CASE 5. ONE-WAY SIMPLY SUPPORTED WALL
       ASS=5.0/384.0
        BSS=0.125
RI=ISUP/ICEN
       GOTO(270,60,70),ICASE4
C
C:  CASE 6. ONE-WAY FIXED END WALL
60 BF=(.00953+.03213*RI)/(.211+.289*RI)
AF=.00132+.01169*RI-BF*(.0223+.1028*RI)
RETURN
C
C:  CASE 7. ONE-WAY PROPPED CANTILEVER WALL
70 BF=(.0109+.0308*RI)/(.1926+.1407*RI)
AF=-.00439-.00342*RI+BF*(.08333+.02083*RI)
270  RETURN
     END
SUBROUTINE TRANS (ICASE4,ZKLM,ZKLMSE,ZKLMFE,ZKLMP,VL1S,VL2S,
+     VL1F,VL2F,VL1P,VL2P)
```

PROGRAM RCBEAM (CONTINUED)

```
C
C  THIS SUBRØUTINE DETERMINES TRANSFØRMATIØN FACTØRS AND
C  DYNAMIC REACTIØN CØEFFICIENTS FØR ØNE-WAY BEAMS
C
C  ALL CASES
 ZKLMSE=0.78
 ZKLMP=0.66
 VL1S=0.107
 VL2S=0.393
 VL1P=0.125
 VL2P=0.375
 GØTØ(300,310,320),ICASE4
C
C  CASE 5
 300 ZKLM=ZKLMSE
 VL1=VL1S
 VL2=VL2S
 RETURN
C
C  CASE 6
 310 ZKLMFE=0.77
 VL1F=0.136
 VL2F=0.364
 GØTØ 330
C
C  CASE 7
 320 ZKLMFE=0.78
 VL1F=0.165
 VL2F=0.459
 330 ZKLM=ZKLMFE
 VL1=VL1F
 VL2=VL2F
 RETURN
 END
      SUBRØUTINE RANDØM (IENTRY)
C THIS SUBRØUTINE INPUTS MEAN AND STANDARD DEVIATIØNS FØR RANDØM
C VARIABLES;  GENERATES RANDØM VALUES;  AND CØNTRØLS REQUIRED
C NUMBER ØF CASES TØ BE RUN;  AND ØUTPUTS FINAL RESULTS AND SUMMARY
C
 CØMMØN KINC,LDTYPE,KRF,KRAND,TIME,II,Y(100),QT,QU,YU,YFAIL,
+  ZLB,BB,HB,FPC,FDY,ICASE,AS(4),APS(4),D(4),DP(4),FDC,
+  EC,ES,QAREA,PAREA,ZMASS,ZKLM,VL1,VL2,
+  MEMB,ASCS,VCL,QDLSLAP,KCØMP,HS,BS,NSLABS,NAMEF(2),KLØAD,
+  W,PØ,CØ,LØC,S,ZLEN,TD,PS3,PDØ,PR,PEXT,PC,TC,TO,DELAY,
+  TT(80,2),PP(80,2),REAC(80,2),INDEX(2),BR(2),
+  NWIN,RHØØ,V3,L1,AA(8,2),NN(8),AFRØNT,ASIDE,G,G2,G3,G4,PP2,DT
      CØMMØN /RAND/ TIMEC
      DIMENSIØN CHI25(7),CHI975(7),TDIST(7)
C
C VALUES FØR 97.5%  (F=19,24,29,34,39,44,49)
      DATA CHI25/.4088,.5167,.5533,.5825,.6065,.6267,.6440/
      DATA CHI975/1.7295,1.6402,1.5766,1.5284,1.4903,1.4591,1.4331/
      DATA TDIST/2.093,2.064,2.045,2.032,2.022,2.016,2.010/
C
      GØTØ(5,50,70),IENTRY
    5 XDUMMY=XNØRM1(-1.0,0.0,1.0)
C INITIALIZE RANDØM NUMBER GENERATØR
      PRINT,/,*INPUT NRAND*,
      READ,NRAND
      DØ 47 I=1,NRAND
      XDUMMY=XNØRM1(0.0,0.0,1.0)
   47 CØNTINUE
      INDEX=0$  SPSØ=0$  SSPSØ=0
      ICHECK=20
C
C  INPUT MEAN AND STANDARD DEVIATIØN FØR RANDØM VARIABLES
      IF(LØC.EQ.2)GØTØ 30
      PRINT 87
      READ,SMEAN,SSD
C  REINFØRCED CØNCRETE WALLS
   30 PRINT 86
      READ,FDYMEAN,FDYSD
      IF(LØC.EQ.1)PRINT 94
      IF(LØC.NE.1)PRINT 95
```

PROGRAM RCBEAM (CONTINUED)

```
70450         RETURN
70460C
70470C  GENERATE RANDØM VALUES
70570   50    FDY=XNØRM1(0.0,FDYMEAN,FDYSD)
70580         IF(FDY.LE.0)GØTØ 50
70585         IF(LØC.EQ.2.ØR.SMEAN.EQ.0)GØTØ 65
70590   60    S=XNØRM1(0.0,SMEAN,SSD)
70600         IF(S.LE.0)GØTØ 60
70610   65    INDEX=INDEX+1
70620         RETURN
70630C SUM VALUES ØF PSØ AND PSØ**2 FØR USE IN STATISTICAL ANALYSIS
70640   70    SPSØ=SPSØ+PSØ
70650         SSPSØ=SSPSØ+PSØ*PSØ
70660C
70670C ØUTPUT FINAL RESULTS
70730   76    IF(LØC.EQ.1)PRINT 92,FDY,S,PSØ,TIMEC
70735         IF(LØC.NE.1)PRINT 90,FDY,PSØ,TIMEC
70740   80    IF(INDEX.LT.ICHECK)RETURN
70750C
70760C DETERMINE MEAN, STANDARD DEVIATIØN, AND STANDARD ERRØR FØR PSØ
70770         ZNØ=INDEX
70780         ZMEAN=SPSØ/ZNØ
70790         SD=SQRT((SSPSØ-ZNØ*ZMEAN*ZMEAN)/(ZNØ))
70800         STDERR=SD/(SQRT(ZNØ-1))
70810C CHECK IF MAXIMUM ØF 50 PSØ SAMPLES ØBTAINED
70820         IF(INDEX.EQ.50)GØTØ 62
70830C CHECK IF 95% CØNFIDENCE INTERVAL FØR MEAN PSØ VALUE IS
70840         IF(STDERR*TDIST((INDEX-15)/5)/ZMEAN.GT.0.10)GØTØ 61
70850C
70860C CØNFIDENCE INTERVAL IS WITHIN 10% -- DETERMINE UPPER LIMIT ØF
70870C 95% CØNFIDENCE INTERVAL FØR STANDARD DEVIATIØN
70890C PRØBABILITY VALUE AND ITS 95% CØNFIDENCE INTERVAL UPPER LIMIT
70890   62    SDU=SD/(SQRT(CHI25((INDEX-15)/5)))
70900C CHECK IF MAXIMUM ØF 50 PSØ SAMPLES ØBTAINED
70910         IF(INDEX.EQ.50)GØTØ 53
70920C CHECK IF UPPER VALUE ØF 95% CØNFIDENCE INTERVAL FØR STANDARD
70930C DEVIATIØN IS WITHIN 0.10*MEAN ØF THE STANDARD DEVIATIØN
70940         IF(((SDU-SD)/ZMEAN).GT.0.10)GØTØ 61
70950C
70960C 95% CØNFIDENCE INTERVAL IS WITHIN 10% FØR BØTH MEAN AND 90%
70970C PRØBABILITY VALUE -- THEREFØRE SUFFICIENT SAMPLES ØBTAINED
70980C DETERMINE 95% CØNFIDENCE INTERVALS FØR MEAN, STANDARD DEVIATIØN
70990,
71000C AND 10% AND 90% PRØBABILITY VALUES
71010   53    ZMEANL=ZMEAN-STDERR*TDIST((INDEX-15)/5)
71020         ZMEANU=ZMEAN+STDERR*TDIST((INDEX-15)/5)
71030         SDL=SD/(SQRT(CHI975((INDEX-15)/5)))
71040         P10=ZMEAN-1.282*SD
71050         P10L=ZMEAN-1.282*SDU
71060         P10U=ZMEAN-1.282*SDL
71070         P90=ZMEAN+1.282*SD
71080         P90L=ZMEAN+1.282*SDL
71090         P90=ZMEAN+1.282*SD
71100         P90U=ZMEAN+1.282*SDU
71110         P90U=ZMEAN+1.282*SDU
71120C
71130C ØUTPUT STATISTICAL PARAMETERS ØF INCIPIENT CØLLAPSE PRESSURE
71140         PRINT 100,ZMEAN,ZMEANL,ZMEANU,SD,SDL,SDU,P10,P10L,P10U,
71150*          P90,P90L,P90U
71160         PRINT 105,INDEX,STDERR
71170         GØTØ 999
71180C
71190C 95% CØNFIDENCE INTERVAL IS NØT WITHIN 10% FØR BØTH MEAN AND 90
71200B
71210C VALUES -- THEREFØRE ØBTAIN 5 ADDITIØNAL SAMPLES
71220   61    ICHECK=ICHECK+5
71230         RETURN
71240C
71270   86 FØRMAT(/*INPUT MEAN AND STANDARD DEVIATIØN FØR FDY*,*)
71280   87 FØRMAT(/*INPUT MEAN AND STANDARD DEVIATIØN FØR S*,*)
71290   90 FØRMAT(F9.2,F10.2,F14.3)
71310   92 FØRMAT(F9.1,F11.2,F10.2,F14.3)
71340   95 FØRMAT(///,5X,*FDY*,7X,*PSØ*,6X,*CØLLAPSE TIME*)
71350   96 FØRMAT(///,5X,*FDY*,9X,*S*,9X,*PSØ*,6X,*CØLLAPSE TIME*)
```

PROGRAM RCBEAM (CONCLUDED)

```
  100 FORMAT(///,11X,*STATISTICAL PROPERTIES OF INCIPIENT PSO*,
+       //,39X,*95% CONFIDENCE LIMITS*,/,7X,*ITEM*,18X,
+       *VALUE       LOWER       UPPER*,//,* MEAN*,F29.2,
+       2F12.2,//,* STANDARD DEVIATION*,F15.2,2F12.2,//,
+       * 10% PROBABILITY VALUE*,3F12.2,//,
+       * 90% PROBABIL.TY VALUE*,3F12.2)
  105 FORMAT(//,5X,*NUMBER OF OBSERVATIONS =*,I3,/,5X,
+       *STANDARD ERROR =*,F5.2)
C
  999 STOPS END
FUNCTION XNORM1(X,A,B)
IF(X)10,20,20
10 X0=RANF(-1.0)
20 X1=RANF(0.0)
X2=RANF(0.0)
Y=SQRT(-2.0*ALOG(X1))*(COS(6.283184*X2))
XNORM1=A+Y*B
RETURN
END
```

STBEAM

Steel Support Beam

PROGRAM STBEAM

```
PRØGRAM STBEAM1(INPUT,ØUTPUT,TAPE1)
CALL RETR(7HSTBEAM2,7HSTBEAM2)
C * THIS PØRTIØN ØF THE PRØGRAM INPUTS THE REQUIRED ELEMENT
C:  AND LØAD DATA AND INITIALIZES CERTAIN PARAMETERS *
C
CØMMØN KINC,LDTYPE,KRF,KRAND,TIME(1,Y(100),DT,DU,YU,YFAIL,
+   ZLB,HB,BFLG,TFLG,TW,FDYS,ICASE,KPLATE,KCAMP,HP,BP,ES,
+   HPC,HS,FPC,FDC,EC,BS,FDYK,AS,D,APS,DP,OAREA,PAREA,ZMASS,
+   ZKLM,VL1,VL2,NSLABS,NAMEF(2),KLØAD,QDLSLAB,
+   W,PØ,CØ,LØC,S,ZLEN,CD,PS1,PD0,PR,PEXT,PC,TC,TO,DELAY,
+   TT(80,2),PP(80,2),REAC(80,2),INDEX(2),BR(2),
+   NWIN,RHIN,V3,L1,AA(8,2),NN(8),AFRØNT,ASIDE,G,G2,G3,G4,PPR,DT
LØGICAL L1
C
C * READ TITLE AND CØNTRØL PARAMETERS
PRINT 67
READ 68,TITLE
PRINT 720
READ,NSLABS,KLØAD
PAREA=0 $ QDLSLAB=0
IF(KLØAD.EQ.0)GØTØ 40
C
C:  INPUT SLAB REACTIØN DATA FILE DATA
PRINT 725
DØ 39 J=1,NSLABS
PRINT 735,J
READ,NAMEF(J),ISIDE
CALL PFUR(3HRET,1,NAMEF(J))
IF(ISIDE.EQ.1)READ(1,)SAREA,DUM,HS
IF(ISIDE.EQ.2)READ(1,)DUM,SAREA,HS
510 INDEX(J)=1
READ(1,)NPØINT
IF(ISIDE.EQ.2)GØTØ 520
515 READ(1,)(TT(JJ,J),PP(JJ,J),REAC(JJ,J),DUM,JJ=1,NPØINT)
GØTØ 525
520 READ(1,)(TT(JJ,J),PP(JJ,J),DUM,REAC(JJ,J),JJ=1,NPØINT)
525 BR(J)=(REAC(2,J)-REAC(1,J))/(TT(2,J)-TT(1,J))
BP=(PP(2,J)-PP(1,J))/(TT(2,J)-TT(1,J))
REWIND 1
CALL DRØP1(1)
QDLSLAB=QDLSLAB+150.0*SAREA*HS/1728.0
39 PAREA=PAREA+SAREA
KINC=0 $ LDTYPE=5 $ KRF=0 $ KRAND=0
GØTØ 45
C
C INPUT TRIBUTARY SLAB DATA
40 PRINT 730
DØ 42 J=1,NSLABS
PRINT 735,J
READ,SAREA,HS
QDLSLAB=QDLSLAB+150.0*SAREA*HS/12.0
42 PAREA=PAREA+SAREA*144.0
C
PRINT 85
READ,KINC,LDTYPE,KRF,KRAND
45 CØNTINUE
DELAY=0
67 FØRMAT(/*INPUT TITLE*,+)
68 FØRMAT(A59)
85 FØRMAT(/*INPUT KINC,LDTYPE,KRF,KRAND(1=RANDØM)*,+)
720 FØRMAT(/*INPUT NUMBER ØF SLABS SUPPØRTED BY BEAM, AND IF *,
+     *SLAB REACTIØNS*/*ARE TØ BE CALCULATED (0) ØR READ FRØM *,
+     *DATA FILE (1)*,+)
725 FØRMAT(/*INPUT REACTIØN DATA FILE NAME AND SIDE *,
+     *(1=SHØRT,2=LØNG)*)
730 FØRMAT(/*INPUT CØNTRIBUTARY AREA (SQ FT) AND THICKNESS (IN.)*)
735 FØRMAT(6X,*FØR SLAB NØ.*,I2,+)
C
C  INPUT LØAD PARAMETERS
IF(LDTYPE.EQ.5)GØTØ 20
C  LØCATIØN 1.  FRØNT FACE LØADING (USED IN RØØM-FILLING PRØCEDURE)
IF(KLØAD.EQ.1)GØTØ 25
100 W=1000.0 $ PØ=14.7 $ CØ=1120.0
IF(KRF.NE.1)GØTØ 102
```

PROGRAM STBEAM (CONTINUED)

```
 LØC=1
 IF(KRAND.EQ.1)GØTØ 106
 PRINT 600
 READ,S
 GØTØ 105
C  LØCATIØN 2. TØP FACE LØADING
 102 CD=0 $ LØC=2
 ZLEN=ZLB/12.0
 105 IF(KINC.EQ.1)GØTØ 106
 PRINT 610
 READ,PSØ
 PR=2.0*PSØ*(7.0*PØ+4.0*PSØ)/(7.0*PØ+PSØ)
 600 FØRMAT(/*INPUT S*,+)
 610 FØRMAT(/*INPUT PSØ*,+)
C
C * INPUT RØØM-FILLING PARAMETERS *
 106 IF(KRF.EQ.0)GØTØ 20
 10 PRINT 700
 RHØØ=0.076 $ L1=.FALSE.
 DELAY=1E10
 READ,NWIN,V3
 AT=0$ AFRØNT=0$ ASIDE=0
 DØ 18 I=1,NWIN
 PRINT 710,I
 READ,AA(I,1),NN(I),AA(I,2)
 AA(I,2)=AA(I,2)/1000.0
 AT=AT+AA(I,1)
 M=NN(I)$ GØTØ(12,14,14),M
 12 AFRØNT=AFRØNT+AA(I,1)
 GØTØ 18
 14 ASIDE=ASIDE+AA(I,1)
 18 IF(AA(I,2).LT.DELAY)DELAY=AA(I,2)
 AFRØNT=AFRØNT/AT$ ASIDE=ASIDE/AT
 700 FØRMAT(/*INPUT NWIN AND RØØM VØLUME (CF)*,+)
 710 FØRMAT(/*INPUT AREA (SQ FT),LØCATIØN CØDE & DELAY(MSEC)*
+     * FØR WINDØW*,I2,+)
 G=1.4 $ G2=1./G $ G3=1.-G2 $ G4=2./G3 $ G5=G+1.
 PP2=.1912
 C=SQRT(G*PØ*32.*144./RHØØ)
 TAU=2.*(V3**(1./3.))/C
 DT=TAU/4.0
C
 20 CØNTINUE
 25 CALL CHAIN(STREAM2)
 99 STØP
 END
 SEGMENT STREAM2(INPUT,ØUTPUT,TAPE1)
C  THIS SEGMENT CALCULATES THE RESISTANCE FUNCTIØN AND
C  LØADING AND SØLVES THE DYNAMIC EQUATIØNS ØF MØTIØN
C
 CØMMØN KINC,LØTYPE,KRF,KRAND,TIME,I,Y(100),DT,DU,YU,YFAIL,
+  ZLB,HB,BFLG,TFLG,TW,FDYS,ICASE,KPLATE,KCØMP,HP,BP,ES,
+  HPC,HS,FPC,FDC,EC,BS,FDYR,AS,D,APS,DF,QAREA,PAREA,ZMASS,
+  ZKLM,VL1,VL2,NSLABS,NAMEF(2),KLØAD,QULSLAB,
+  W,PØ,CØ,LØC,S,ZLEN,CD,PSØ,PDØ,PF,PEXT,PC,TC,TO,DELAY,
+  TT(80,2),PP(80,2),REAC(80,2),INDEX(2),BR(2),
+  NWIN,RHØØ,V3,L1,AA(8,2),NN(8),AFRØNT,ASIDE,G,G2,G3,G4,PP2,DT
 CØMMØN /RAND/ TIMEC
 DIMENSIØN A(100),V(100),T(100),VS(100),VL(100),PV(100)
C
       CALL RESIST(1)
 IF(KINC.NE.1.ØR.LØTYPE.EQ.5)CALL FØRCE(1)
 14    IF(KRAND.NE.1)GØTØ 35
       CALL FØRCE(4)
       CALL RANDØM(1)
 34    CALL RANDØM(2)
 35    CALL RESIST(3)
C
C: MINIMUM, MAXIMUM, AND STARTING VALUES ARE DETERMINED FØR CASES
C: WHERE THE LØAD CAUSING INCIPIENT CØLLAPSE IS TØ BE FØUND
 13    IF(KINC.EQ.0)GØTØ 23
 PF=4.0
        PFMAX=0
        PFMIN=PF/2.0
```

```
      GØTØ 20
16     PF=(PFMIN+PFMAX)/2.0
20    CALL FØRCE(2)
23    IF(KRF.EQ.0)GØTØ 24
      CALL FILL(PINT,2)
C
C:  INITIALIZE VALUES FØR BETA METHØD (BETA=1/6) AND CØMPUTE VALUES
C:  FØR FIRST TIME INTERVAL ASSUMING ELEMENT INITIALLY AT REST
24     I=1
       TIME=0
      V(I)=0 $ Y(I)=0
       DELTA=0.001
      IF(KRF.NE.1)GØTØ 30
27    IF(TIME.GE.(DELAY-.00001))GØTØ 30
      TIME=TIME+DELTA
      CALL FILL(PINT,3)
      GØTØ 2
30    CALL RESIST(2)
      A(I)=0.0 $ VS(I)=0.0 $ VL(I)=0.0
      T(I)=TIME
C
C: PRØCEDURE FØR ALL SUBSEQUENT TIME INTERVALS
1      I=I+1
      IF(I.LT.101)GØTØ 11
      PRINT 98,TIME
98 FØRMAT(/*I=101; TIME =*,F6.3,*; FAILURE ASSUMED TØ NØT ØCCUR*)
      GØTØ 6
11    TIME=TIME+DELTA
       T(I)=TIME
       A(I)=A(I-1)
      IF(KRF.NE.0)GØTØ 10
      CALL FØRCE(2)
      PN(I)=PEXT
      GØTØ 2
10    CALL FILL(PINT,3)
      PN(I)=PINT
2 IF(KLØAD.EQ.0)PT=PN(I)*PAREA
IF(KLØAD.NE.0)PT=PN(I)
      DO 8 J=1,10
       Y(I)=Y(I-1)+DELTA*V(I-1)+DELTA*DELTA*(A(I-1)/3.+A(I)/6.)
       CALL RESIST(2)
  ANEW=(PT-QT)/(ZMASS*ZKLM)
       ADELTA=ANEW-A(I)
       A(I)=ANEW
IF(ANEW.EQ.0)PRINT,*1985*,TIME,PT,QT,ZMASS,ZKLM,Y(I),A(I-1)
      IF(ABS(ADELTA/(ANEW+1E-10)).LT.0.01) GØTØ 9
8      CØNTINUE
       A(I)=ANEW-ADELTA/2.0
PRINT 50,TIME,PF,A(I),Y(I)
9      CØNTINUE
       Y(I)=Y(I-1)+DELTA*V(I-1)+DELTA*DELTA*(A(I-1)/3.+A(I)/6.)
       V(I)=V(I-1)+DELTA*(A(I)+A(I-1))/2.0
VL(I)=VL1*PT+VL2*QT
C
C: CHECK FØR MAXIMUM DEFLECTIØN ØR FAILURE
C:    IF MAXIMUM DEFLECTIØN REACHED, WALL DID NØT FAIL
       IF(Y(I).LE.Y(I-1).AND.PN(I).LE.PN(I-1))GØTØ 6
       IF(Y(I).LT.0)GØTØ 6
       IF(Y(I).GE.YFAIL)GØTØ 7
       IF(TIME-DELAY.GE.0.010)DELTA=0.002
       IF(TIME-DELAY.GE.0.020)DELTA=0.005
       IF(TIME-DELAY.GE.0.100)DELTA=0.010
       IF(TIME-DELAY.GE.0.500)DELTA=0.050
C:    IF FAILURE DEFLECTIØN REACHED, ELEMENT FAILED
        GØTØ 1
C
C: INTERVAL HALVING PRØCEDURE TØ DETERMINE LØAD CAUSING INCIPIENT
C: CØLLAPSE FØR CASES WHERE DESIRED
C:    ELEMENT DID NØT FAIL -- SET PFMIN TØ PF
6      CØNTINUE
       IF(KINC.EQ.0)GØTØ 18
36     PFMIN=PF
IF(PFMAX.GT.0)GØTØ 16
        PF=2.0*PF
```

PROGRAM STBEAM (CONTINUED)

```
02320         GØTØ 20
02330C:    ELEMENT FAILED -- SET PFMAX TØ PF
02340 7     CØNTINUE
02350       TIMEC=TIME
02370       IF(KINC.EQ.0)GØTØ 18
02380 37    PFMAX=PF
02390C:   CHECK TØ SEE IF LØAD RANGE IS WITHIN DESIRED ACCURACY
02400 17     IF((PFMAX-PFMIN)/PFMIN.GT.0.01)GØTØ 16
02410       IF(KRAND.NE.1)GØTØ 18
02420       CALL RANDØM(3)
02430       GØTØ 34
02440C
02450C: ØUTPUT DATA INCLUDES THE MAXIMUM DEFLECTIØN AND TIME ØF
02460C: ØCCURANCE FØR A NØN-FAILING ELEMENT, ØR THE TIME AND VELØCITY
02470C: AT CØLLAPSE FØR A FAILING ELEMENT.  ØPTIØNAL ØUTPUT IS THE
02480C: ENTIRE BEHAVIØR TIME-HISTØRY.
02490C
02500C: ØUTPUT LØAD DATA
02510 18    CALL FØRCE(4)
02520C
02530C: ØUTPUT FINAL RESULTS
02540 IF(Y(I).LT.YFAIL)PRINT 70,Y(I),T(I)
02550 IF(Y(I).GE.YFAIL)PRINT 71,T(I),V(I)
02577C
02578C CHECK TØ SEE IF ENTIRE TIME-HISTØRY IS DESIRED
02580 PRINT 72
02590 READ,M
02600       IF(M.EQ.0)GØTØ 25
02680 PRINT 76,(T(J),PV(J),A(J),V(J),Y(J),VL(J),J=1,I)
02690 25 PRINT 77
02710C
02740 70 FØRMAT(/*NØ FAILURE - MAX DEFLECTIØN ØF*,F6.2,
02750+    * IN. REACHED AT*F7.3,* SEC*)
02760 71 FØRMAT(/*FAILURE ØCCURRED AT*,F7.3,* SEC (FINAL VELØCITY =*,
02770+   F7.2* IN./SEC)*)
02780 72 FØRMAT(/*IS TIME HISTØRY DESIRED (YES=1, NØ=0)*,+)
02830 76 FØRMAT(/*  TIME  PRESSURE  ACCELERATIØN  VELØCITY  *
02840+   *DISPLACEMENT    VL*,/,
02850+   (F6.3,F9.3,F12.1,F12.2,F12.4,F11.0))
02860 77     FØRMAT(///,7(*----------*))
02870 80 FØRMAT(/*ACCELERATIØN NØT CØNVERGING AT TIME =*,F6.3,
02880+          * SEC (PF =*,F7.3,* PSI)*/*     A(I) SET EQUAL TØ*,
02890+          F8.1,* (AVG ØF LAST 2 ITERATIØNS)*/*     Y(I) =*,
02900+          F8.4,* IN.*)
02950C
02960 999    STØP
02970        END
10000 SUBRØUTINE FØRCE(IENTRY)
10010C  THIS SUBRØUTINE INPUTS THE LØAD PARAMETERS AND DETERMINES
10020C  THE LØAD AT A GIVEN TIME FØR THE FØLLØWING LØAD TYPES:
10030C      1. IDEALIZED BLAST LØAD (FRØNT ØR SIDE FACE)
10050 CØMMØN KINC,LDTYPE,KRF,KRAND,TIME,I,Y(100),DT,QU,YU,YFAIL,
10052+  ZLB,HB,BFLG,TFLG,TW,FDYS,ICASE,KPLATE,KCØMP,HP,BP,ES,
10054+  HPC,HS,FPC,FDC,EC,BS,FDYR,AS,D,APS,DP,QAREA,PAREA,ZMASS,
10055+  ZKLM,VL1,VL2,NSLABS,NAMEF(2),KLØAD,QDLSLAB,
10056+  W,PØ,CØ,LSC,S,ZLEN,CD,PSØ,PDØ,PR,P,PC,TC,TO,DELAY,
10057+  TT(80,2),PP(80,2),REAC(80,2),,NDEX(2),BR(2)
10058+  NWIN,PHØØ,V3,L1,AA(8,2),NN(8),AFRØNT,ASIDE,G,G2,G3,G4,PP2,DT
10080C
10130 IF(LDTYPE.EQ.5)GØTØ 700
10135 IF(KLØAD.EQ.1)GØTØ 500
10140C
10150 GØTØ(215,200,300,4),IENTRY
11000C
11010C  CALCULATE LØAD PRØPERTIES FØR GIVEN PEAK PRESSURE
11030 200 GØTØ(205,210),LSC
11040 205 PSØ=(PR-14.0*P3+SQRT(196.0*P3*P3+196.0*P3*PR+PR*PR))/16.0
11050 GØTØ 215
11060 210 PSØ=PR
11070 215 PDØ=2.5*PSØ*PSØ/(7.0*P3+PSØ)
11080 U=CØ*SQRT(1.0+(6.0*PSØ)/(7.0*PØ))
11090 TO=W**0.3333/(2.2399+0.1886*PSØ)
11100 GØTØ(220,225),LSC
11110 220 TC=3.0*S/U
```

```
PC=PS0*(1-TC/TO)*EXP(-TC/TO)+PD0*(1-TC/TO)**2*EXP(-2*TC/TO)
CD=1.0
RETURN
225 TA=ZLEN/U
TA2=TA/2.0
TA2TO=TA2/TO
PA=PS0*(1-TA2TO)*EXP(-TA2TO)+CD*PD0*(1-TA2TO)**2*EXP(-2*TA2TO)
RETURN
C
C  CALCULATE LOAD
300 GOTO(305,310),LOC
305 TTO=TIME/TO
IF(TIME.GT.TC)GOTO 320
P=PC+(TC-TIME)*(PR-PC)/TC
RETURN
310 TTO=(TIME-TA2)/TO
IF(TIME.GT.TA)GOTO 320
P=PA*TIME/TA
RETURN
320 IF(TTO.GE.1.0)GOTO 330
P=PS0*(1-TTO)*EXP(-TTO)+CD*PD0*(1-TTO)**2*EXP(-2*TTO)
RETURN
330 P=0
RETURN
C
C  PRINT LOAD DATA
4 IF(KINC.EQ.0)GOTO 400
PRINT 640,LDTYPE
GOTO 410
400 PRINT 645,LDTYPE
410 CONTINUE
415 GOTO(420,425),LOC
420 PRINT 650
GOTO 430
425 PRINT 655
430 PRINT 660,W,P0,C0
IF(KRAND.NE.0)RETURN
GOTO(435,440),LOC
435 PRINT 665,S,TC,PR
GOTO 445
440 PRINT 670,ZLEN,TA,PA
445 PRINT 675,U,TO,CD,PS0,PD0
RETURN
C
C  LOAD TYPE 5 -- ARBITRARY LOAD SHAPE
700 GOTO(710,720,730,740),IENTRY
C
C  INPUT LOAD DATA
710 PRINT 780
READ,NPOINT,(TT(J,1),PP(J,1),J=1,NPOINT)
FACTOR=1.0
IF(KINC.EQ.0)GOTO 718
PMAX=PP(1,1)
DO 715 J=2,NPOINT
715 IF(PP(J,1).GT.PMAX)PMAX=PP(J,1)
718 PX=PP(2,1)-PP(1,1)
TX=TT(2,1)-TT(1,1)
JJ=1
RETURN
C
C  CALCULATE MAXIMUM LOAD
720 FACTOR=PR/PMAX
GOTO 718
RETURN
C
C  CALCULATE LOAD
730 IF(TIME.LE.TT(JJ+1,1))GOTO 735
JJ=JJ+1
PX=PP(JJ+1,1)-PP(JJ,1)
TX=TT(JJ+1,1)-TT(JJ)
IF(TX.EQ.0)TX=1E-10
GOTO 730
735 P=FACTOR*(PP(JJ,1)+(TIME-TT(JJ,1))*PX/TX)
RETURN
```

PROGRAM STBEAM (CONTINUED)

```
 00C
13810C   PRINT LOAD DATA
13815 740 IF(KINC.EQ.1)PRINT 640,LDTYPE
13820 IF(KINC.EQ.0)PRINT 645,LDTYPE
13825 PRINT 780
13830 DO 745 J=1,NPOINT
13840 P=FACTOR*PP(J,1)
13850 745 PRINT 795,TT(J,1),P
13860 RETURN
14000C
14070 640 FORMAT(/*LOAD CAUSING INCIPIENT FAILURE IS AS FOLLOWS:*,
14071+     /,5X,*LOAD TYPE NUMBER*,I2)
14080 645 FORMAT(/*PROPERTIES OF LOAD ACTING ON WALL ARE AS FOLLOWS:*,
14081+     /,5X,*LOAD TYPE NUMBER*,I2)
14090 650 FORMAT(8X,*(FRONT FACE)*)
14100 655 FORMAT(5X,*(SIDE OR TOP FACE)*)
14110 660 FORMAT(10X,*W =*,F8.1,* KT    PO =*,F6.2,* PSI      CO =*,
14111+     F7.1,* FPS*)
14120 665 FORMAT(10X,*S =*,F6.1,* FT      TC =*,F6.3,* SEC      PR =*,
14121+     F7.3,* PSI*)
14130 670 FORMAT(10X,*L =*,F6.1,* FT      TA =*,F6.3,* SEC      PA =*,
14131+     F7.3,* PSI*)
14140 675 FORMAT(10X,*U =*,F7.1,* FPS   TO =*,F6.3,* SEC      CD =*,
14141+     F5.1,/,8X,*PSO =*,F7.3,* PSI   PDO =*,F7.3,* PSI*)
14150 780 FORMAT(/*INPUT NUMBER OF LOAD POINTS AND THE TIME AND *
14151+     *PRESSURE AT EACH POINT*)
14160 790 FORMAT(/10X,*TIME        PRESSURE*)
14170 795 FORMAT(F15.3,F12.2)
15000C
15002C:  SLAB REACTION DATA
15010 500 GOTO(510,530,540,560),IENTRY
15020 510 RETURN
15085C
15090 530 STOP
15095C
15100 540 P=0.0
15110 DO 555 J=1,NSLABS
15115 545 JJ=INDEX(J)
15120 550 IF(TIME.LE.TT(JJ+1,J))GOTO 555
15125 INDEX(J)=INDEX(J)+1 $ JJ=INDEX(J)
15130 IF(JJ.LT.NPOINT)GOTO 552
15132 PRINT 690,TIME
15133 STOP
15135 552 BR(J)=(REAC(JJ+1,J)-REAC(JJ,J))/(TT(JJ+1,J)-TT(JJ,J))
15140 BP=(PP(JJ+1,J)-PP(JJ,J))/(TT(JJ+1,J)-TT(JJ,J))
15150 GOTO 550
15160 555 P=P+REAC(JJ,J)+(TIME-TT(JJ,J))*BR(J)
15165 P=P+OAREA*(PP(JJ,J)+(TIME-TT(JJ,J))*BP)
15170 RETURN
15180 560 PRINT 680
15190 DO 565 J=1,NSLABS
15200 565 PRINT 685,NAMEF(J)
15300 680 FORMAT(/*BEAM LOADED WITH REACTIONS FROM FILE(S):*)
15310 685 FORMAT(10X,A7)
15315 690 FORMAT(/*END OF FILE -- BEAM HAS NOT FAILED AT*,F6.3,* SEC*)
15320 RETURN
15330 END
20000 SUBROUTINE FILL(P3,IENTRY)
20010C: COMPUTES AVERAGE AIR PRESSURE IN ROOM DUE TO BLAST WAVE
20020C: INCIDENT HEAD-ON UPON FRONT WALL.
20030C
20050 COMMON KINC,LDTYPE,KRF,KRAND,TIME,I,Y(100),DT,DU,YU,YFAIL,
20052+  ZLB,HB,BFLG,TFLG,TW,FDYS,ICASE,KPLATE,KCOMP,HP,BP,ES,
20054+  HPC,HS,FPC,FDC,EC,BS,FDYR,AS,D,APS,DP,OAREA,PAREA,ZMASS,
20055+  ZKLM,VL1,VL2,NSLABS,NAMEF(2),KLOAD,DOLSLAB,
20056+  W,P3,CO,L3C,S,ZLEN,CD,PSO,PDO,PR,PCXT,PC,TC,TO,DELAY,
20057+  TT(80,2),PP(80,2),REAC(80,2),INDEX(2),BR(2),
20058+  NWIN,RHOO,V3,L1,AA(8,2),NN(8),AFRONT,ASIDE,G,G2,G3,G4,PP2,DT
20090 LOGICAL L1,L2,L3
20095C
20100 GOTO(10,13,11),IENTRY
20110 10 RETURN
20310C
20320 13 P30=P3
```

PROGRAM STBEAM (CONTINUED)

```
TT=0.$ TØ=0.
RHØ33=RHØØ
L2=.FALSE. $ L3=.FALSE.
RETURN
C
11 IF(L1)GØTØ 52
IF(L2.A.L3)GØTØ 9
52 DDT=(TIME-TØ)*0.5
ISTØP=2
53 IF(DDT.LT.DT)GØTØ 51
50 DDT=0.5*DDT
ISTØP=2*ISTØP
GØ TØ 53
51 CØNTINUE
DØ 99 I=1,ISTØP
TT=TØ+I*DDT
IF(TT.GT.TO)GØ TØ 99
DM=0. $ WW=0. $ NW=0
DØ 500 K=1,NWIN
M=NN(K) $ DLY=AA(K,2)+0.000001
IF(DLY.GE.TT)GØ TØ 500
GØTØ(15,16,16),M
15 CDF=1.0
IF(TT-TC)20,20,21
20 P11=(TC-TT)*(PR-PC)/TC+PC
P11=P11+PØ
GØ TØ 30
16 CDF=-0.4
21 R=TT/TO $ RR=1.-R
PD=PDØ*RR*RR*EXP(-2.*R)
PS=PSØ*RR*EXP(-R)
P11=PS+CDF*PD
P11=P11+PØ
30 RHØ1=RHØØ*((P11/PØ)**G2)
IF(P11-PØØ)36,36,37
36 JSIGN=-1
L2=.TRUE.
303 P2=P11
RHØ2=((P2/PØØ)**G2)*RHØ33
X=PØØ/RHØ33
GØ TØ 38
37 JSIGN=+1
306 P2=PP2*P11
RHØ2=((P2/P11)**G2)*RHØ1
X=P11/RHØ1
38 U22=G4*(X-P2/RHØ2)*32.*144.
IF(U22)40,39,39
40 PRINT,*U22 NEGATIVE*,U22
STØP
39 U2=SQRT(U22)*JSIGN
DDM=U2*RHØ2*AA(K,1)*DDT
DM=DM+DDM
WW=WW+P11*DDM/(G3*RHØ1)
C
500 CØNTINUE
PØØ=PØØ+(G-1.)*WW/V3
RHØØ=RHØØ+DM/V3
99 CØNTINUE
TØ=TT
P3=PØØ-PØ
IF(TIME.GE.TC)L3=.TRUE.
RETURN
9 R=TIME*1.0-R
PD=PDØ*RR*RR*EXP(-2.0*R)
PS=PSØ*RR*EXP(-R)
P3=PS+PD*(AFRØNT-0.4*ASIDE)
999 RETURN
END
SUBRØUTINE RESIST (IENTRY)
C: THIS SUBRØUTINE DETERMINES THE RESISTANCE FUNCTIØN,
C: TRANSFØRMATIØN FACTØRS, AND REACTIØN CØEFFICIENTS, AND
C: SUPPLIES THE REACTIØN VALUES FØR SPECIFIC DEFLECTIØNS
C
CØMMØN KINC,LDTYPE,KRF,KRAND,TIME,I,Y(100),DT,QU,YU,YFAIL,
```

```
+    ZLB,HB,BFLG,TFLG,TW,FDYS,ICASE,KPLATE,KCOMP,HP,BP,ES,
+    HPC,HS,FPC,FDC,EC,BS,FDYR,AS,D,APS,DP,QAREA,PAREA,ZMASS,
+    ZKLM,VL1,VL2,NSLABS,NAMEF(2),KLOAD,QDLSLAB,
+    W,PO,CO,LOC,S,ZLEN,CD,PSO,POD,PR,PEXT,PC,TC,TO,DELAY,
+     [illegible](80,2),PP(80,2),REAC(80,2),INDEX(2),BR(2),
+          RHOO,V3,L1,AA(8,2),NN(8),AFRONT,ASIDE,G,G2,G3,G4,PP2,DT
 REAL      B,ISTEEL,ICC,ICS,IAVG,KK1,KK2,KS1,KS2
 GOTO(4,500,45),IENTRY
C
C * ENTRY 1:  INPUT BEAM DATA *
 4 PRINT 615
 READ,ZLB,HB,BFLG,TFLG,TW,FDYS,ICASE,KPLATE,KCOMP
 ZLEN=ZLB/12.0
 ICASE4=ICASE-4
 ES=29E6
 BP=0 $ HP=0
 IF(KPLATE.EQ.0)GOTO 11
 PRINT 616
 READ,BP,HP
 11 IF(KCOMP.EQ.0)GOTO 13
 PRINT 618
 READ,HBP,HS,FPC
 FDC=1.25*FPC
 EC=57619.0*SQRT(FPC) $ ECKIP=EC/1000.0
 N=ES/EC
C * EFFECTIVE WIDTH OF CONCRETE *
 BS=ZLB/4.0
 IF(BS.GT.BFLG+16.0*HS)BS=BFLG+16.0*HS
 IF(ICASE.EQ.5)GOTO 13
 PRINT 619
 READ,FDYR,AS,D,APS,DP
 13 CONTINUE
 QAREA=ZLB*BFLG
 PAREA=PAREA+QAREA
C
C * OUTPUT BEAM DATA *
 PRINT 620,ICASE,ZLB,HB,BFLG,TFLG,TW,FDYS
 IF(KPLATE.NE.0)PRINT 625,BP,HP
 IF(KCOMP.EQ.0)GOTO 15
 PRINT 630,HBP,HS,BS,FPC,FDC,ECKIP
 IF(ICASE.GT.5)PRINT 635,AS,D,FDYR,APS,DP
 AS=AS*BS/12.0 $ APS=APS*BS/12.0
 15 CONTINUE
C
C * DETERMINE BEAM PROPERTIES INDEPENDENT OF FDY *
 CALL TRANS(ICASE4,ZKLM,ZKLMSE,ZKLMFE,ZKLMP,VL1S,VL2S,
+              VL1F,VL2F,VL1P,VL2P)
C *  PROPERTIES FOR STEEL SECTION *
 AFLG=BFLG*TFLG
 AB=2.0*AFLG+TW*(HB-2.0*TFLG)
 AP=HP*BP
 ASTEEL=AB+AP
 ZMASS=490.0*ASTEEL*ZLB/1728.0
 IB=2.0*(BFLG*TFLG**3/12.0+AFLG*(0.5*(HB-TFLG))**2)
+    +TW*(HB-2.0*TFLG)**3/12.0
 YS=0.5*(HB+HP)*AP/ASTEEL
 YBS=0.5*HB+HP-YS
 YTS=0.5*HB+YS
 H1=HBP+YTS
 ISTEEL=IB+AB*YS*YS+BP*HP**3/12.0+AP*(YBS-0.5*HP)**2
 ZS=AFLG*(HB-TFLG)+TW*((0.5*HB-TFLG)**2-YS*YS)+AP*(YBS-0.5*HP)
 IF(KCOMP.EQ.1)RETURN
 ZCC=ZS $ ZCS=ZS
 ICC=ISTEEL $ ICS=ISTEEL
 RETURN
C
C * ENTRY 3: DETERMINE BEAM PROPERTIES DEPENDENT ON FDY *
 45 IF(KCOMP.NE.1)GOTO 78
C *  PROPERTIES FOR COMPOSITE SECTION *
 ASR=AS*FDYR/FDYS $ APSR=APS*FDYR/FDYS
C
C *  NEGATIVE MOMENT SECTION *
 IF(ICASE.EQ.5)GOTO 50
 YC=(ASR*(HS-D)+APSR*(HS-DP)+ASTEEL*H1)/(ASR+APSR+ASTEEL)
```

PROGRAM STBEAM (CONTINUED)

```
30830 ICS=ASR*(YC-HS+D)**2+APSR*(YC-HS+DP)**2+ISTEEL
30840+      +ASTEEL*(HBP+YTS-YC)**2
30850 ASTELP=0.5*(ASTEEL-ASR-APSR)
30860 ZTC=TFLG+(ASTELP-AFLG)/TW
30870 E=YTS+HBP-HS+D
30880 EP=YTS+HBP-HS+DP
30890 EPP=YTS-0.5*TFLG
30900 EPPP=EPP-0.5*ZTC
30910 ZCS=ASR*E+APSR*EP+2.0*AFLG*EPP+2.0*(ASTELP-AFLG)*EPPP
30930C
30940C *  PØSITIVE MØMENT SECTIØN *
30950C *    ELASTIC MØMENT ØF INERTIA *
30960 50 TERM1=N*ASTEEL/BS
30970 YC=-TERM1+SQRT(TERM1*TERM1+2.0*TERM1*H1)
30980 IF(YC.GT.HS)GØTØ 55
30990C *     NEUTRAL AXIS IN SLAB *
31000 ICC=ISTEEL+ASTEEL*(H1-YC)**2+BS*YC**3/(3.0*N)
31010 GØTØ 60
31020C *     NEUTRAL AXIS BELØW SLAB *
31030 55 YC=(BS*HS*HS+2.0*N*ASTEEL*H1)/(2.0*(BS*HS+N*ASTEEL))
31040 ICC=ISTEEL+ASTEEL*(H1-YC)**2+BS*HS**3/(12.0*N)
31050+      +BS*HS*(YC-0.5*HS)**2/N
31060C *    PLASTIC SECTIØN MØDULUS *
31070 60 BSU=0.85*FDC*BS/FDYS
31090 ZC=ASTEEL/BSU
31100 IF(ZC.GT.HS)GØTØ 65
31110 IF(ZC.GT.HBP)GØTØ 62
31120C *     NEUTRAL AXIS IN SLAB (ABØVE BEAM FLANGE) *
31130 ZCC=ASTEEL*(YTS+HBP-0.5*ZC)
31140 GØTØ 75
31150C *     NEUTRAL AXIS BELØW BEAM FLANGE (ENCASED BEAM) *
31160 62 ACU=BSU*HBP
31170 E=YTS+0.5*HBP
31180 GØTØ 68
31190C *     NEUTRAL AXIS BELØW SLAB *
31200 65 ACU=BSU*HS
31210 E=YTS+HBP-0.5*HS
31220 68 ASTELP=0.5*(ASTEEL-ACU)
31230 IF(ASTELP.GT.AFLG)GØTØ 70
31240C *       NEUTRAL AXIS IN BEAM FLANGE *
31250 ZC=HBP+ASTELP/BFLG
31260 ZCC=ACU*E+2.0*ASTELP*(YTS-0.5*(ZC-HBP))
31270 GØTØ 75
31280C *       NEUTRAL AXIS IN BE[illegible] WEB *
31290 70 ZC=(ASTELP-AFLG)/TW+[illegible]-TFLG
31300 EP=YTS-0.5*TFLG
31310 EPP=EP-0.5*(ZC-HBP)
31320 ZCC=ACU*E+2.0*AFLG*EP+[illegible]ELP-AFLG)*EPP
31330 75 CØNTINUE
31350C
31360C *  DETERMINE RESISTANCE [illegible] (TØTAL) FØR BEAM *
31370C *  (Q IS IN UNITS ØF LB, K[illegible] IN LB/IN. AND Y IN INCHES ) *
31375 78 CALL CØEF(ICASE4,ASS,BSS,AF,BF,ICC,ICS)
31380 IF(ICASE.GT.5)GØTØ 80
31390C
31400C CASE 5
31410 QU=ZCC*FDYS/(BSS*ZLB)
31420 KK1=ES*ICC/(ASS*ZLB**3)
31430 YU=QU/KK1
31440 QFAIL=ZS*FDYS/(BSS*ZLB)
31450 YFAIL=26.4*QFAIL/(ES*ISTEEL/(ASS*ZLB**3))
31460 GØTØ 100
31470C
31480C CASES 6 AND 7
31490 80 Q1=ZCS*FDYS/(BF*ZLB)
31500 IAVG=0.5*(ICC+ICS)
31510 KK1=ES*ICS/(AF*ZLB**3)
31520 Y1=Q1/KK1
31530 IF(ICASE.EQ.7)GØTØ 85
31540 QU=FDYS*(ZCC+ZCS)/(BSS*ZLB)
31550 QFAIL=2.0*FDYS*ZS/(BSS*ZLB)
31555 QS1=FDYS*ZS*12.0/ZLB
31556 KS1=ES*ISTEEL*384.0/ZLB**3
31560 GØTØ 90
```

PROGRAM STBEAM (CONTINUED)

```
85 QU=FDYS*(ZCC+0.5*ZCS)/(BSS*ZLB)
QFAIL=1.5*FDYS*ZS/(BSS*ZLB)
QS1=FDYS*8.0/ZLB
KS1=ES*ISTEEL*185.0/ZLB**3
90 KK2=ES*IAVG/(ASS*ZLB**3)
YU=Y1+(QU-Q1)/KK2
YS1=QS1/KS1
KS2=ES*ISTEEL/(ASS*ZLB**3)
YSU=YS1+(QFAIL-QS1)/KS2
YFAIL=26.4*(YS1+YSU*(1.0-QS1/QFAIL))
C
C * ADJUST RESISTANCE CURVE FOR SLAB DEAD LOAD *
100 QDL=QDLSLAB+490.0*ASTEEL*ZLB/1728.0
YDL=QDL/KK1
IF(KRAND.NE.1)PRINT 633,QDL,YDL
Y1=Y1-YDL$ YU=YU-YDL$ YFAIL=YFAIL-YDL
Q1=Q1-QDL$ QU=QU-QDL$ QFAIL=QFAIL-QDL
C
C * OUTPUT RESISTANCE CURVE *
IF(KRAND.EQ.1)GOTO 335
PRINT 650
IF(ICASE.EQ.5)GOTO 320
PRINT 660,Q1,Y1
320 PRINT 660,QU,YU,QFAIL,YFAIL
335 CONTINUE
RETURN
C
C * ENTRY 2: DETERMINE THE RESISTANCE (TOTAL) OF THE BEAM
C             AS A FUNCTION OF Y(I) *
C
500 IF(Y(I).GT.YFAIL)GOTO 560
IF(Y(I).GT.YU)GOTO 540
IF(ICASE.GT.5)GOTO 520
C
C * ELASTIC RANGE - CASE 5 *
ZKLM=ZKLMSE
VL1=VL1S $ VL2=VL2S
QT=Y(I)*KK1
RETURN
C
520 IF(Y(I).GT.Y1)GOTO 530
C
C * ELASTIC RANGE - CASES 6 & 7 *
ZKLM=ZKLMEE
VL1=VL1E $ VL2=VL2E
QT=Y(I)*KK1
RETURN
C
C * ELASTO-PLASTIC RANGE - CASES 6 & 7 *
530 ZKLM=ZKLMSE
VL1=VL1S $ VL2=VL2S
QT=Q1+KK2*(Y(I)-Y1)
RETURN
C
C * PLASTIC RANGE - ALL CASES *
540 ZKLM=ZKLMP
VL1=VL1P $ VL2=VL2P
QT=QU+(Y(I)-YU)*(QFAIL-QU)/(YFAIL-YU)
RETURN
C
C * BEAM COLLAPSED (SET RESISTANCE TO SMALL VALUES) *
560 QT=1E-10
RETURN
C
615 FORMAT(/*INPUT LB,HB,BF,TF,TW,FDYS,ICASE,KPLATE,KCOMP*)
616 FORMAT(/*INPUT BP & HP (FOR BOTTOM COVER PLATE)*,+)
618 FORMAT(/*INPUT HBP,HS,F'C (FOR COMPOSITE BEAM)*,+)
619 FORMAT(/*INPUT FDYR & AS,D,APS,DP AT BEAM SUPPORT*,+)
620 FORMAT(//*PROPERTIES OF STEEL SUPPORT BEAM -- SUPPORT TYPE NO.*,
     I2,/,*  LB =*,F6.1,* IN.*,5X,*HB =*,F6.2,* IN.*,6X,*BF =*,
     F7.3,* IN.*,/,*  TF =*,F6.3,* IN.*,5X,*TW =*,F6.3,* IN.*,4X,
     *FDYS =*,F8.1,* PSI*)
625 FORMAT(/*  BP =*,F6.2,* IN.*,5X,*HP =*,F6.3,* IN.*)
630 FORMAT(/* HBP =*,F6.2,* IN.*,5X,*HS =*,F6.2,* IN.*,4X,
```

PROGRAM STBEAM (CONTINUED)

```
32340+     *  BS =*,F6.2,* IN.*,/,* F'C =*,F7.1,* PSI    FDC =*,
32350+     F7.1,* PSI*,5X,*EC =*,F7.1,* KSI*)
32360 635 FORMAT(/*  AS =*,F7.4,* SQ IN./FT*,6X,*D =*,F7.3,* IN.*,
32370+     4X,*FDYR =*,F8.1,* PSI*,/,* A'S =*,F7.4,* SQ IN./FT*,5X,
32380+     *D' =*,F7.3,* IN.*)
32390 633 FORMAT(/*QDL =*,F10.2,* LB    YDL =*,F8.4,* IN.*)
32400 650 FORMAT(//*LOAD-DEFLECTION CURVE*,/,5X,*QT (LB)       Y (IN.)*)
32410 660 FORMAT(F12.2,F12.4)
32420 END
40000 SUBROUTINE COEF (ICASE4,ASS,BSS,AF,BF,ICEN,ISUP)
40010C
40020C  THIS SUBROUTINE DETERMINES DEFLECTION AND MOMENT COEFFICIENTS
40030C  FOR TEE BEAMS WITH VARIABLE MOMENT OF INERTIA
40040C
40050 REAL ICEN,ISUP
40060C:  CASE 5. ONE-WAY SIMPLY SUPPORTED WALL
40070      ASS=5.0/384.0
40080       BSS=0.125
40090 RI=ISUP/ICEN
40100      GOTO(270,60,70),ICASE4
40110C
40120C:  CASE 6. ONE-WAY FIXED END WALL
40130 60 BF=(.00953+.03213*RI)/(.211+.289*RI)
40140 AF=.00132+.01169*RI-BF*(.0223+.1023*RI)
40150 RETURN
40160C
40170C:  CASE 7. ONE-WAY PROPPED CANTILEVER WALL
40180 70 BF=(.0109+.0306*RI)/(.1926+.1407*RI)
40190 AF=-.00439-.00342*RI+BF*(.08333+.02083*RI)
40200 270  RETURN
40210      END
50000 SUBROUTINE TRANS (ICASE4,ZKLM,ZKLMSE,ZKLMFE,ZKLMP,VL1S,VL2S,
50010+     VL1F,VL2F,VL1P,VL2P)
50020C
50030C  THIS SUBROUTINE DETERMINES TRANSFORMATION FACTORS AND
50040C  DYNAMIC REACTION COEFFICIENTS FOR ONE-WAY BEAMS
50050C
50060C  ALL CASES
50070 ZKLMSE=0.78
50080 ZKLMP=0.66
50090 VL1S=0.107
50100 VL2S=0.393
50110 VL1P=0.125
50120 VL2P=0.375
50130 GOTO(300,310,320),ICASE4
50140C
50150C  CASE 5
50160 300 ZKLM=ZKLMSE
50170 VL1=VL1S
50180 VL2=VL2S
50190 RETURN
50200C
50210C  CASE 6
50220 310 ZKLMFE=0.77
50230 VL1F=0.136
50240 VL2F=0.364
50250 GOTO 330
50260C
50270C  CASE 7
50280 320 ZKLMFE=0.78
50290 VL1F=0.165
50300 VL2F=0.459
50310 330 ZKLM=ZKLMFE
50320 VL1=VL1F
50330 VL2=VL2F
50340 RETURN
50350 END
70000      SUBROUTINE RANDOM (IENTRY)
70010C THIS SUBROUTINE INPUTS MEAN AND STANDARD DEVIATIONS FOR RANDOM
70020C VARIABLES;  GENERATES RANDOM VALUES;  AND CONTROLS REQUIRED
70030C NUMBER OF CASES TO BE RUN;  AND OUTPUTS FINAL RESULTS AND SUMMARY
70040C
70050 COMMON KINC,LDTYPE,KRF,KRAND,TIME,I,Y(100),QT,QU,YU,YFAIL,
70052+  ZLB,HB,BFLG,TFLG,TW,FDYS,ICASE,KPLATE,KCOMP,HP,BP,ES,
```

PROGRAM STBEAM (CONTINUED)

```
+   HPC,HS,FPC,FDC,SC,PS,FDYR,AS,D,APS,DP,DAREA,PAREA,ZMASS,
+   ZKL4,VL1,VL2,NSLABS,NAMEF(2),KLOAD,TOLSLAB,
+   W,P,C3,LOC,S,ZLE4,CD,PSO,PDO,PR,PEXT,PC,TC,TO,DELAY,
+   TT(80,2),PP(80,2),REAC(80,2),INDEX(2),BR(2),
+   NWIN,RHOB,V3,L1,AA(8,2),NN(8),AFRINT,ASIDE,G,G2,G3,G4,PP2,DT
      COMMON /RAND/ TIMEC
      DIMENSION CHI25(7),CHI975(7),TDIST(7)
C
C VALUES FOR 97.5%  (F=19,24,29,34,39,44,49)
      DATA CHI25/.4688,.5167,.5533,.5825,.6065,.6267,.6440/
      DATA CHI975/1.7295,1.6402,1.5766,1.5284,1.4903,1.4591,1.4331/
      DATA TDIST/2.093,2.064,2.045,2.032,2.022,2.016,2.010/
C
      GOTO(5,50,70),IENTRY
    5 XDUMMY=XNORM1(-1.0,0.0,1.0)
C INITIALIZE RANDOM NUMBER GENERATOR
      PRINT,/,*INPUT NRAND*,
      READ,NRAND
      DO 47 I=1,NRAND
      XDUMMY=XNORM1(0.0,0.0,1.0)
   47 CONTINUE
      INDEX=0$  SPSO=0$  SSPSO=0
      ICHECK=20
C
C  INPUT MEAN AND STANDARD DEVIATION FOR RANDOM VARIABLES
      IF(LOC.EQ.2)GOTO 30
      PRINT 87
      READ,SMEAN,SSD
C  STEEL (NON-COMPOSITE AND COMPOSITE) SUPPORT BEAMS
   30 PRINT 86
      READ,FDYSMEN,FDYSSD
      IF(KCOMP.EQ.1.AND.ICASE.GT.5)GOTO 40
      IF(LOC.EQ.1)PRINT 96
      IF(LOC.NE.1)PRINT 95
      RETURN
   40 PRINT 88
      READ,FDYRMEN,FDYRSD
      IF(LOC.EQ.1)PRINT 97
      IF(LOC.NE.1)PRINT 98
      RETURN
C
C  GENERATE RANDOM VALUES
   50 FDYS=XNORM1(0.0,FDYSMEN,FDYSSD)
      IF(FDYS.LE.0)GOTO 50
      IF(KCOMP.NE.1.OR.ICASE.EQ.5)GOTO 58
   55 FDYR=XNORM1(0.0,FDYRMEN,FDYRSD)
      IF(FDYR.LE.0.AND.FDYRMEN.NE.0)GOTO 55
   58 CONTINUE
      IF(LOC.EQ.2.OR.SMEAN.EQ.0)GOTO 65
   60 S=XNORM1(0.0,SMEAN,SSD)
      IF(S.LE.0)GOTO 60
   65 INDEX=INDEX+1
      RETURN
C SUM VALUES OF PSO AND PSO**2 FOR USE IN STATISTICAL ANALYSIS
   70 SPSO=SPSO+PSO
      SSPSO=SSPSO+PSO*PSO
C
C OUTPUT FINAL RESULTS
   76 IF(KCOMP.EQ.1.AND.ICASE.GT.5)GOTO 78
      IF(LOC.EQ.1)PRINT 92,FDYS,S,PSO,TIMEC
      IF(LOC.NE.1)PRINT 90,FDYS,PSO,TIMEC
      GOTO 80
   78 IF(LOC.EQ.1)PRINT 93,FDYS,FDYR,S,PSO,TIMEC
      IF(LOC.NE.1)PRINT 94,FDYS,FDYR,PSO,TIMEC
   80 IF(INDEX.LT.ICHECK)RETURN
C
C DETERMINE MEAN, STANDARD DEVIATION, AND STANDARD ERROR FOR PSO
      ZNO=INDEX
      ZMEAN=SPSO/ZNO
      SD=SQRT((SSPSO-ZNO*ZMEAN*ZMEAN)/ZNO)
      STDERR=SD/(SQRT(ZNO-1))
C CHECK IF MAXIMUM OF 50 PSO SAMPLES OBTAINED
      IF(INDEX.EQ.50)GOTO 62
C CHECK IF 95% CONFIDENCE INTERVAL FOR MEAN PSO VALUE IS
```

PROGRAM STBEAM (CONCLUDED)

```
      IF(STDERR*TDIST((INDEX-15)/5)/ZMEAN.GT.0.10)GOTO 61
C
C CONFIDENCE INTERVAL IS WITHIN 10% -- DETERMINE UPPER LIMIT OF
C 95% CONFIDENCE INTERVAL FOR STANDARD DEVIATION
C PROBABILITY VALUE AND ITS 95% CONFIDENCE INTERVAL UPPER LIMIT
   62 SDU=SD/(SQRT(CHI25((INDEX-15)/5)))
C CHECK IF MAXIMUM OF 50 PSI SAMPLES OBTAINED
      IF(INDEX.EQ.50)GOTO 53
C CHECK IF UPPER VALUE OF 95% CONFIDENCE INTERVAL FOR STANDARD
C DEVIATION IS WITHIN 0.10*MEAN OF THE STANDARD DEVIATION
      IF(((SDU-SD)/ZMEAN).GT.0.10)GOTO 61
C
C 95% CONFIDENCE INTERVAL IS WITHIN 10% FOR BOTH MEAN AND 90%
C PROBABILITY VALUE -- THEREFORE SUFFICIENT SAMPLES OBTAINED
C DETERMINE 95% CONFIDENCE INTERVALS FOR MEAN, STANDARD DEVIATION
C
C AND 10% AND 90% PROBABILITY VALUES
   53 ZMEANL=ZMEAN-STDERR*TDIST((INDEX-15)/5)
      ZMEANU=ZMEAN+STDERR*TDIST((INDEX-15)/5)
      SDL=SD/(SQRT(CHI975((INDEX-15)/5)))
      P10=ZMEAN-1.282*SD
      P10L=ZMEAN-1.282*SDU
      P10U=ZMEAN-1.282*SDL
      P90=ZMEAN+1.282*SD
      P90L=ZMEAN+1.282*SDL
      P90=ZMEAN+1.282*SD
      P90U=ZMEAN+1.282*SDU
      P90U=ZMEAN+1.282*SDU
C
C OUTPUT STATISTICAL PARAMETERS OF INCIPIENT COLLAPSE PRESSURE
      PRINT 100,ZMEAN,ZMEANL,ZMEANU,SD,SDL,SDU,P10,P10L,P10U,
     +  P90,P90L,P90U
      PRINT 105,INDEX,STDERR
      GOTO 999
C
C 95% CONFIDENCE INTERVAL IS NOT WITHIN 10% FOR BOTH MEAN AND 90%
C
C VALUES -- THEREFORE OBTAIN 5 ADDITIONAL SAMPLES
   61 ICHECK=ICHECK+5
      RETURN
C
   86 FORMAT(/*INPUT MEAN AND STANDARD DEVIATION FOR FOYS*,*)
   87 FORMAT(/*INPUT MEAN AND STANDARD DEVIATION FOR S*,*)
   88 FORMAT(/*INPUT MEAN AND STANDARD DEVIATION FOR FOYR*,*)
   90 FORMAT(F9.2,F10.2,F14.3)
   92 FORMAT(F9.1,F11.2,F10.2,F14.3)
   93 FORMAT(2F9.1,F11.2,F10.2,F14.3)
   94 FORMAT(2F9.1,F10.2,F14.3)
   95 FORMAT(///,4X,*FOYS*,7X,*PSI*,6X,*COLLAPSE TIME*)
   96 FORMAT(///,4X,*FOYS*,7X,*S*,3X,*PSI*,6X,*COLLAPSE TIME*)
   97 FORMAT(///,4X,*FOYS*,7X,*FOYR*,3X,*S*,5X,*PSI*,6X,
     +  *COLLAPSE TIME*)
   98 FORMAT(///,4X,*FOYS*,7X,*FOYR*,7X,*PSI*,6X,*COLLAPSE TIME*)
  100 FORMAT(///,11X,*STATISTICAL PROPERTIES OF INCIPIENT PSI*,
     +  //,39X,*95% CONFIDENCE LIMITS*,/,7X,*ITEM*,18X,
     +  *VALUE        LOWER         UPPER*,//,* MEAN*,F23.2,
     +  2F12.2,//,* STANDARD DEVIATION*,F15.2,2F1[illegible],//,
     +  * 10% PROBABILITY VALUE*,3F12.2,//,
     +  * 90% PROBABILITY VALUE*,3F12.2)
  105 FORMAT(//,5X,*NUMBER OF OBSERVATIONS =*,I3,/,5X,
     +  *STANDARD ERROR =*,F[illegible].2)
C
  999 STOP $ END
      FUNCTION XNORM(X,A,B)
      IF(X)10,20,20
   10 X0=RANF(-1.0)
   20 X1=RANF(0.0)
      X2=RANF(0.0)
      X=SQRT(-2.0*ALOG(X1))*(COS(6.2831854*X2))
      XNORM=A+X*B
      RETURN
      END
```

FLAT

Flat Slab or Flat Plate

PROGRAM FLAT

```
PROGRAM FLAT(INPUT,OUTPUT)
C:  THIS ROUTINE IS THE CONTROLLING ROUTINE FOR THE PROGRAM
C:  USED IN THE ANALYSIS OF REINFORCED CONCRETE FLAT SLABS
C
COMMON KINC,LDTYPE,KRF,KRAND,TIME,I,Y(100),Q,QU,YU,YFAIL,
+  ZLS,HS,FDY,AREA,ZMASS,ZKLM,VS1,VS2,PS0,PD0,PF,PEXT,PC,TC,TO,
+  P0,DELAY,S
DIMENSION A(80),V(80),T(80),VS(80),QQ(80),PN(80)
COMMON /SHEAR/ ISHEAR,JSHEAR,V.,.EAR,MEMB
COMMON /RAND/ TIMEC
C
C * READ TITLE AND CONTROL PARAMETERS *
5 PRINT 67
READ 68,TITLE
PRINT 85
READ,KINC,LDTYPE,KRF,KRAND
DELAY=0
CALL RESIST(1)
CALL FORCE(1)
IF(KRF.EQ.0)GOTO 14
CALL FILL(PINT,1)
14    IF(KRAND.NE.1)GOTO 35
      CALL FORCE(4)
      CALL RANDOM(1)
34    CALL RANDOM(2)
35    CALL RESIST(3)
C
C: MINIMUM, MAXIMUM, AND STARTING VALUES ARE DETERMINED FOR CASES
C: WHERE THE LOAD CAUSING INCIPIENT COLLAPSE IS TO BE FOUND
13    IF(KINC.EQ.0)GOTO 23
       PF=QU
       PFMAX=0
       PFMIN=PF/2.0
      GOTO 20
16     PF=(PFMIN+PFMAX)/2.0
20    CALL FORCE(2)
23    IF(KRF.EQ.0)GOTO 24
      CALL FILL(PINT,2)
C
C:  INITIALIZE VALUES FOR BETA METHOD (BETA=1/6) AND COMPUTE VALUES
C:  FOR FIRST TIME INTERVAL ASSUMING ELEMENT INITIALLY AT REST
24     I=1
       TIME=0
      V(1)=0 $ Y(1)=0
       DELTA=0.001
JSHEAR=0
      IF(KRF.NE.1)GOTO 30
27    IF(TIME.GE.(DELAY-.00001))GOTO 30
      TIME=TIME+DELTA
      CALL FILL(PINT,3)
      GOTO 27
30    CALL RESIST(2)
      A(1)=0.0 $ VS(1)=0.0
      T(1)=TIME
C
C PROCEDURE FOR ALL SUBSEQUENT TIME INTERVALS
       I=I+1
      IF(I.LT.81)GOTO 11
      PRINT 98,TIME
98 FORMAT(/*I=81:  TIME =*,F6.3,*,  FAILURE ASSUMED TO NOT OCCUR*)
      GOTO 6
11    TIME=TIME+DELTA
       T(I)=TIME
       A(I)=A(I-1)
      IF(KRF.NE.0)GOTO 10
      CALL FORCE(3)
      PN(I)=PEXT
      GOTO 2
10    CALL FILL(PINT,3)
      PN(I)=PINT
2     CONTINUE
      DO 8 JJ=1,10
       Y(I)=Y(I-1)+DELTA*V(I-1)+DELTA*DELTA*(A(I-1)/3.+A(I)/6.)
       CALL RESIST(2)
```

```
4     ANEW=AREA*(PN(I)-Q)/(ZMASS*ZKLM)
       ADELTA=ANEW-A(I)
       A(I)=ANEW
IF(ANEW.EQ.0)PRINT,*1985*,TIME,PN(I),Q,ZMASS,ZKLM,Y(I),A(I-1)
       IF(ABS(ADELTA/(ANEW+1E-10)).LT.0.01)GOTO 9
8      CONTINUE
       A(I)=ANEW-ADELTA/2.0
PRINT 80,TIME,PF,A(I),Y(I)
9      CONTINUE
       Y(I)=Y(I-1)+DELTA*V(I-1)+DELTA*DELTA*(A(I-1)/3.+A(I)/6.)
       V(I)=V(I-1)+DELTA*(A(I)+A(I-1))/2.0
      VS(I)=AREA*(VS1*PN(I)+VS2*Q)
      QQ(I)=Q
IF(ISHEAR.EQ.1.AND.VS(I).GT.VSHEAR)JSHEAR=1
IF(JSHEAR.EQ.1.AND.MEMB.EQ.0)GOTO 7
C
C: CHECK FOR MAXIMUM DEFLECTION OR FAILURE
C:    IF MAXIMUM DEFLECTION REACHED, WALL DID NOT FAIL
      IF(Y(I).LE.Y(I-1).AND.PN(I).LE.PN(I-1))GOTO 6
      IF(Y(I).LT.0)GOTO 6
      IF(Y(I).GE.YFAIL)GOTO 7
      IF(TIME-DELAY.GE.0.010)DELTA=0.002
      IF(TIME-DELAY.GE.0.020)DELTA=0.005
      IF(TIME-DELAY.GE.0.100)DELTA=0.010
      IF(TIME-DELAY.GE.0.500)DELTA=0.050
C:    IF FAILURE DEFLECTION REACHED, ELEMENT FAILED
       GOTO 1
C
C: INTERVAL HALVING PROCEDURE TO DETERMINE LOAD CAUSING INCIPIENT
C: COLLAPSE FOR CASES WHERE DESIRED
C:    ELEMENT DID NOT FAIL -- SET PFMIN TO PF
6     CONTINUE
      IF(KINC.EQ.0)GOTO 18
36    PFMIN=PF
IF(PFMAX.GT.0)GOTO 16
       PF=2.0*PF
       GOTO 20
C:    ELEMENT FAILED -- SET PFMAX TO PF
7      CONTINUE
       TIMEC=TIME
       IF(KINC.EQ.0)GOTO 18
37    PFMAX=PF
C:    CHECK TO SEE IF LOAD RANGE IS WITHIN DESIRED ACCURACY
17     IF((PFMAX-PFMIN)/PFMIN.GT.0.01)GOTO 16
      IF(KRAND.NE.1)GOTO 15
      CALL RANDOM(3)
      GOTO 34
C
C: OUTPUT DATA INCLUDES THE MAXIMUM DEFLECTION AND TIME OF
C: OCCURANCE FOR A NON-FAILING ELEMENT OR THE TIME AND VELOCITY
C: AT COLLAPSE FOR A FAILING ELEMENT.  OPTIONAL OUTPUT IS THE
C: ENTIRE BEHAVIOR TIME-HISTORY.
C
C: OUTPUT LOAD DATA
18     CALL FORCE(4)
C
C: OUTPUT FINAL RESULTS
IF(JSHEAR.EQ.1.AND.MEMB.EQ.0)GOTO 40
IF(Y(I).LT.YFAIL)PRINT 70,Y(I),T(I)
IF(Y(I).GE.YFAIL)PRINT 71,T(I),V(I)
IF(JSHEAR.EQ.1)PRINT 96
GOTO 42
C
C CHECK TO SEE IF ENTIRE TIME-HISTORY IS DESIRED
40 PRINT 97,T(I),V(I)
42 PRINT 72
READ,M
       IF(M.EQ.0)GOTO 25
PRINT 76,(T(J),PN(J),A(J),V(J),Y(J),QQ(J),VS(J),J=1,I)
25 PRINT 77
GOTO 5
C
67 FORMAT(/*INPUT TITLE*,*)
68 FORMAT(A59)
```

```
02740 70 F[illegible]MAT(/*NØ FAILURE - MAX DEFLECTIØN ØF*,F6.2,
02750+     * IN. REACHED AT*F7.3,* SEC*)
02760 71 F[illegible]AT(/*FAILURE ØCCURRED AT*,F7.3,* SEC (FINAL VELØCITY =*,
02770+    [illegible]* IN./SEC)*)
02780 72 FØ[illegible]S TIME HISTØRY DESIRED (YES=1, NØ=0)*,+)
02830 76 F[illegible]        TIME  PRESSURE  ACCELERATIØN  VELØCITY  *
02840+    *[illegible]ENT     QU        VS*,/,
02850+    (F[illegible].3,[illegible].3,F12.1,F12.2,F12.4,F10.2,F9.0))
02860 77     FØRMAT(///,7(*-----------*))
02870 80 FØRMAT(/*ACCELERATIØN NØT CØNVERGING AT TIME =*,F6.3,
02880+           * SEC (PF =*,F7.3,* PSI)*/*     A(I) SET EQUAL TØ*,
02890+           F8.1,* (AVG ØF LAST 2 ITERATIØNS)*/*     Y(I) =*,
02900+           F8.4,* IN.*)
02910 85 FØRMAT(/*INPUT KINC,LDTYPE,KRF,KRAND(1=RANDØM)*,+)
02930 90 FØRMAT(/*ARE REACTIØNS TØ BE ØUTPUT TØ FILE (0=NØ,1=YES)*,+)
02940 95 FØRMAT(/*INPUT NAME ØF SLAB REACTIØN DATA FILE*,+)
02945 96 FØRMAT(/*SHEAR FAILURE -- TENSILE MEMBRANE RESISTANCE*,
02946+    * CØNTINUED*)
02948 97 FØRMAT(/*SHEAR FAILURE AT*,F7.3,* SEC (FINAL VELØCITY =*,
02949+    F7.2* IN./SEC)*)
02950C
02960 999    STØP
02970        END
10000 SUBRØUTINE FØRCE(IENTRY)
10010C  THIS SUBRØUTINE INPUTS THE LØAD PARAMETERS AND DETERMINES
10020C  THE LØAD AT A GIVEN TIME FØR THE FØLLØWING LØAD TYPES:
10030C      1. IDEALIZED BLAST LØAD (FRØNT ØR SIDE FACE)
10050 CØMMØN KINC,LDTYPE,KRF,KRAND,TIME,I,Y(100),Q,QU,YU,YFAIL,
10052+  ZLS,HS,FDY,AREA,ZMASS,ZKLM,VS1,VS2,PSØ,PDØ,PR,P,PC,TC,TØ,
10054+  PØ,DELAY,S
10060 DIMENSIØN TT(20),PP(20)
10120C
10130 IF(LDTYPE.EQ.5)GØTØ 500
10140C
10150 GØTØ(100,200,300,4),IENTRY
10160C
10170C * INPUT LØAD PARAMETERS *
10180C: LØCATIØN 1. FRØNT FACE LØADING (USED IN RØØM-FILLING PRØCEDURE)
10190 100 W=1000.0 $ PØ=14.7 $ CØ=1120.0
10200 IF(KRF.NE.1)GØTØ 102
10210 LØC=1
10220 IF(KRAND.EQ.1)RETURN
10230 PRINT 600
10240 READ,S
10250 GØTØ 105
10260C: LØCATIØN 2. TØP FACE LØADING
10265 102 CD=0 $ LØC=2
10270 ZLEN=ZLS/12.0
10275 105 IF(KINC.EQ.1)RETURN
10280 PRINT 610
10285 READ,PSØ
10290 PR=2.0*PSØ*(7.0*PØ+4.0*PSØ)/(7.0*PØ+PSØ)
10295 GØTØ 215
11000C
11010C  CALCULATE LØAD PRØPERTIES FØR GIVEN PEAK PRESSURE
11030 200 GØTØ(205,210),LØC
11040 205 PSØ=(PR-14.0*PØ+SQRT(196.0*PØ*PØ+196.0*PØ*PR+PR*PR))/16.0
11050 GØTØ 215
11060 210 PSØ=PR
11070 215 PDØ=2.5*PSØ*PSØ/(7.0*PØ+PSØ)
11080 U=CØ*SQRT(1.0+(6.0*PSØ)/(7.0*PØ))
11090 TØ=W**0.3333/(2.2399+0.1886*PSØ)
11100 GØTØ(220,225),LØC
11110 220 TC=3.0*S/U
11120 PC=PSØ*(1-TC/TØ)*EXP(-TC/TØ)+PDØ*(1-TC/TØ)**2*EXP(-2*TC/TØ)
11130 CD=1.0
11140 RETURN
11150 225 TA=ZLEN/U
11160 TA2=TA/2.0
11170 TA2TØ=TA2/TØ
11180 PA=PSØ*(1-TA2TØ)*EXP(-TA2TØ)+CD*PDØ*(1-TA2TØ)**2*EXP(-2*TA2TØ)
11190 RETURN
12000C
12010C  CALCULATE LØAD
```

PROGRAM FLAT (CONTINUED)

```
12030 300 GØTØ(305,310),LØC
12040 305 TTO=TIME/TO
12050 IF(TIME.GT.TC)GØTØ 320
12060 P=PC+(TC-TIME)*(PR-PC)/TC
12070 RETURN
12080 310 TTO=(TIME-TA2)/TO
12090 IF(TIME.GT.TA)GØTØ 320
12100 P=PA*TIME/TA
12110 RETURN
12120 320 IF(TTO.GE.1.0)GØTØ 330
12130 P=PSØ*(1-TTO)*EXP(-TTO)+CD*PDØ*(1-TTO)**2*EXP(-2*TTO)
12150 RETURN
12160 330 P=0
12170 RETURN
13000C
13010C  PRINT LØAD DATA
13020 4 IF(KINC.EQ.0)GØTØ 400
13030 PRINT 640,LDTYPE
13040 GØTØ 410
13050 400 PRINT 645,LDTYPE
13060 410 CØNTINUE
13070 415 GØTØ(420,425),LØC
13080 420 PRINT 650
13090 GØTØ 430
13100 425 PRINT 655
13110 430 PRINT 660,W,PØ,CØ
13120 IF(KRAND.NE.0)RETURN
13130 GØTØ(435,440),LØC
13140 435 PRINT 665,S,TC,PR
13150 GØTØ 445
13160 440 PRINT 670,ZLEN,TA,PA
13170 445 PRINT 675,U,TO,CD,PSØ,PDØ
13180 RETURN
13500C
13510C  LØAD TYPE 5 -- ARBITRARY LØAD SHAPE
13520 500 GØTØ(510,520,530,540),IENTRY
13530C
13540C  INPUT LØAD DATA
13550 510 PRINT 680
13560 READ,NPØINT,(TT(J),PP(J),J=1,NPØINT)
13570 FACTØR=1.0
13580 IF(KINC.EQ.0)GØTØ 518
13590 PMAX=PP(1)
13600 DØ 515 J=2,NPØINT
13610 515 IF(PP(J).GT.PMAX)PMAX=PP(J)
13620 518 PX=PP(2)-PP(1)
13630 TX=TT(2)-TT(1)
13640 JJ=1
13650 RETURN
13660C
13670C  CALCULATE MAXIMUM LØAD
13680 520 FACTØR=PR/PMAX
13690 GØTØ 518
13700 RETURN
13710C
13720C  CALCULATE LØAD
13730 530 IF(TIME.LE.TT(JJ+1))GØTØ 535
13740 JJ=JJ+1
13750 PX=PP(JJ+1)-PP(JJ)
13760 TX=TT(JJ+1)-TT(JJ)
13765 IF(TX.EQ.0)TX=1E-10
13770 GØTØ 530
13780 535 P=FACTØR*(PP(JJ)+(TIME-TT(JJ))*PX/TX)
13790 RETURN
13800C
13810C  PRINT LØAD DATA
13815 540 IF(KINC.EQ.1)PRINT 640,LDTYPE
13820 IF(KINC.EQ.0)PRINT 645,LDTYPE
13825 PRINT 690
13830 DØ 545 J=1,NPØINT
13840 P=FACTØR*PP(J)
13850 545 PRINT 695,TT(J),P
13860 RETURN
14000C
```

```
14010 600 FØRMAT(/*INPUT S*,↑)
14020 610 FØRMAT(/*INPUT PSØ*,↑)
14070 640 FØRMAT(/*LØAD CAUSING INCIPIENT FAILURE IS AS FØLLØWS:*,
14071+     /,5X,*LØAD TYPE NUMBER*,I2)
14080 645 FØRMAT(/*PRØPERTIES ØF LØAD ACTING ØN WALL ARE AS FØLLØWS:*,
14081+     /,5X,*LØAD TYPE NUMBER*,I2)
14090 650 FØRMAT(8X,*(FRØNT FACE)*)
14100 655 FØRMAT(5X,*(SIDE ØR TØP FACE)*)
14110 660 FØRMAT(10X,*W =*,F8.1,* KT   PØ =*,F6.2,* PSI     CØ =*,
14111+     F7.1,* FPS*)
14120 665 FØRMAT(10X,*S =*,F6.1,* FT      TC =*,F6.3,* SEC     PR =*,
14121+     F7.3,* PSI*)
14130 670 FØRMAT(10X,*L =*,F6.1,* FT      TA =*,F6.3,* SEC     PA =*,
14131+     F7.3,* PSI*)
14140 675 FØRMAT(10X,*U =*,F7.1,* FPS   TO =*,F6.3,* SEC     CD =*,
14141+     F5.1,/,8X,*PSØ =*,F7.3,* PSI  PDØ =*,F7.3,* PSI*)
14150 680 FØRMAT(/*INPUT NUMBER ØF LØAD PØINTS AND THE TIME AND *
14151+     *PRESSURE AT EACH PØINT*)
14160 690 FØRMAT(/10X,*TIME       PRESSURE*)
14170 695 FØRMAT(F15.3,F12.2)
15000 END
20000 SUBRØUTINE FILL(P3,IENTRY)
20010C: CØMPUTES AVERAGE AIR PRESSURE IN RØØM DUE TØ BLAST WAVE
20020C: INCIDENT HEAD-ØN UPØN FRØNT WALL.
20030C
20050 CØMMØN KINC,LDTYPE,KRF,KRAND,TIME,II,Y(100),Q,QU,YU,YFAIL,
20052+  ZLS,HS,FDY,AREA,ZMASS,ZKLM,VS1,VS2,PSØ,PDØ,PR,PEXT,PC,TC,TO,
20054+  PØ,DELAY,S
20080 DIMENSIØN AA(8,2),NN(8)
20090 LØGICAL L1,L2,L3
20095C
20100 GØTØ(10,13,11),IENTRY
20105C
20110 10 PRINT 700
20120 READ,NWIN,V3
20122 RHØØ=0.076 $ L1=.FALSE.
20123 DELAY=1E10
20125 AT=0 $ AFRØNT=0 $ ASIDE=0
20130 DØ 18 I=1,NWIN
20140 PRINT 710,I
20150 READ,AA(I,1),NN(I),AA(I,2)
20160 AA(I,2)=AA(I,2)/1000.0
20161 AT=AT+AA(I,1)
20162 M=NN(I) $ GØTØ(12,14,14),M
20163 12 AFRØNT=AFRØNT+AA(I,1)
20164 GØTØ 18
20165 14 ASIDE=ASIDE+AA(I,1)
20170 18 IF(AA(I,2).LT.DELAY)DELAY=AA(I,2)
20175 AFRØNT=AFRØNT/AT $ ASIDE=ASIDE/AT
20180 700 FØRMAT(/*INPUT NUMBER ØF ØPENINGS AND RØØM VØLUME (CF)*,↑)
20200 710 FØRMAT(/*INPUT AREA (SQ FT),LØCATIØN CØDE & DELAY(MSEC) *,
20210+     *FØR WINDØW*,I2,↑)
20230 G=1.4 $ G2=1./G $ G3=1.-G2 $ G4=2./G3
20240 PP2=.1912
20250 C=SQRT(G*PØ*32.*144./RHØØ)
20260 TAU=2.*(V3**(1./3.))/C
20270 DT=TAU/4.0
20280 RETURN
20310C
20320 13 P3Ø=PØ
20330 TT=0.$ TØ=0.
20340 RHØ3Ø=RHØØ
20350 L2=.FALSE. $ L3=.FALSE.
20360 RETURN
20370C
20380 11 IF(L1)GØTØ 52
20385 IF(L2.A.L3)GØTØ 9
20390 52 DDT=(TIME-TØ)*0.5
20395 ISTØP=2
20400 53 IF(DDT.LT.DT)GØTØ 51
20410 50 DDT=0.5*DDT
20415 ISTØP=2*ISTØP
20420 GØ TØ 53
20430 51 CØNTINUE
```

PROGRAM FLAT (CONTINUED)

```
DØ 99 I=1,ISTØP
TT=TØ+I*DDT
IF(TT.GT.TO)GØ TØ 99
DM=0. $ WW=0. $ NW=0
DØ 500 K=1,NWIN
M=NN(K) $ DLY=AA(K,2)+0.000001
IF(DLY.GE.TT)GØ TØ 500
GØTØ(15,16,16),M
15 CDF=1.0
IF(TT-TC)20,20,21
20  P11=(TC-TT)*(PR-PC)/TC+PC
P11=P11+PØ
GØ TØ 30
16 CDF=-0.4
21  R=TT/TO $ RR=1.-R
PD=PDØ*RR*RR*EXP(-2.*R)
PS=PSØ*RR*EXP(-R)
P11=PS+CDF*PD
P11=P11+PØ
30  RHØ1=RHØØ*((P11/PØ)**G2)
IF(P11-P3Ø)36,36,37
36  JSIGN=-1
L2=.TRUE.
303  P2=P11
RHØ2=((P2/P3Ø)**G2)*RHØ3Ø
X=P3Ø/RHØ3Ø
GØ TØ 38
37  JSIGN=+1
306 P2=PP2*P11
RHØ2=((P2/P11)**G2)*RHØ1
X=P11/RHØ1
38  U22=G4*(X-P2/RHØ2)*32.*144.
IF(U22)40,39,39
40  PRINT,*U22 NEGATIVE*,U22
STØP
39  U2=SQRT(U22)*JSIGN
DDM=U2*RHØ2*AA(K,1)*DDT
DM=DM+DDM
WW=WW+P11*DDM/(G3*RHØ1)
C
500 CONTINUE
P3Ø=P3Ø+(G-1.)*WW/V3
RHØ3Ø=RHØ3Ø+DM/V3
99  CONTINUE
TØ=TT
P3=P3Ø-PØ
IF(TIME.GE.TC)L3=.TRUE.
RETURN
9 R=TIME/TO $ RR=1.0-R
PD=PDØ*RR*RR*EXP(-2.0*R)
PS=PSØ*RR*EXP(-R)
P3=PS+PD*(AFRØNT-0.4*ASIDE)
999 RETURN
END
SUBRØUTINE RESIST(IENTRY)
C * THIS SUBRØUTINE DETERMINES THE RESISTANCE FUNCTIØN,
C:  TRANSFØRMATIØN FACTØRS, AND REACTIØN CØEFFICIENTS FØR
C:  A REINFØRCED CØNCRETE FLAT SLAB
C
CØMMØN KINC,LDTYPE,KRF,KRAND,TIME,I,Y(100),Q,QU,YU,YFAIL,
+  ZLS,HS,FDY,AREA,ZMASS,ZKLM,VS1,VS2,PSØ,PDØ,PR,PEXT,PC,TC,TO,
+  PØ,DELAY,S
CØMMØN /SHEAR/ ISHEAR,JSHEAR,VSHEAR,MEMB
REAL N,IG,MU(4),ICR(4),IC,IAVG,KE
DIMENSIØN AS(4),APS(4),D(4),DP(4)
C
GØTØ(4,500,45),IENTRY
C
C * ENTRY 1. INPUT AND ECHØ SLAB AND REINFØRCEMENT PRØPERTIES *
4 PRINT 600
READ,ZLS,C2,HS,FPC,FDY,ZLD,HD
FDC=1.25*FPC
EC=57619.0*SQRT(FPC)
ES=29E6
```

PROGRAM FLAT (CONTINUED)

```
AREA=ZLS*ZLS-C2*C2
ECKIP=EC/1000.0 $ ESKIP=ES/1000.0
PRINT 670
DO 8 I=1,4
PRINT 610,I
8 READ,AS(I),D(I),APS(I),DP(I)
PRINT 720
READ,ISHEAR
PRINT 711
READ,MEMB
IF(MEMB.EQ.0)GOTO 15
PRINT 706
READ,ASCS
ASCS=ASCS/12.0
C
C * DETERMINE PROPERTIES INDEPENDENT OF FDY *
15 N=ES/EC
ZMASS=150.0*AREA*HS/(150.0*1728.0)
PRINT 620,ZLS,C2,HS,FPC,FDC,ECKIP,FDY,ESKIP,ZLD,HD
PRINT 630
DO 110 I=1,4
P=AS(I)/(12.0*D(I)) $ PP=APS(I)/(12.0*D(I))
PRINT 640,I,AS(I),P,D(I),APS(I),PP,DP(I)
C * CHANGE UNITS OF REINFORCEMENT FROM SQ IN./FT TO SQ IN./IN.
AS(I)=AS(I)/12.0 $ APS(I)=APS(I)/12.0
110 CONTINUE
IG=HS**3/12+(N-1)*(AS(1)*(D(1)-HS/2)**2+APS(1)*(HS/2-DP(1))**2)
RETURN
C
C * ENTRY 2. DETERMINE WALL PROPERTIES DEPENDENT ON FDY *
45 CALL MOMENT(FDC,FDY,ES,N,O,1.0,AS,APS,D,DP,MU,ICR,IC)
SUMMP=MU(1)+MU(2)+MU(3)+MU(4)
IAVG=0.5*(IG+ICR(1))
C
C * DETERMINE RESISTANCE CURVE FOR SLAB *
QU=4.0*(ZLS+C2)*SUMMP/(ZLS*AREA)
KE=189.0*EC*IAVG/(ZLS-0.5*C2)**4
YU=QU/KE
YT=999.9
YFAIL=YU*0.1/(AS(1)/D(1))
IF(YFAIL.GT.30.0*YU)YFAIL=30.0*YU
IF(MEMB.NE.1)GOTO 25
C * TENSILE MEMBRANE BEHAVIOR *
20 TS=ASCS*FDY
YT=QU*ZLS*ZLS/(20.25*TS)
QT=QU
IF(YT.LE.YFAIL)GOTO 22
YT=YFAIL
QT=20.25*YT*TS/(ZLS*ZLS)
22 IF(YFAIL.LT.0.15*ZLS)YFAIL=0.   *ZLS
QFAIL=0.15*20.25*TS/ZLS
C
C * ADJUST LOAD-DEFLECTION CURVE FOR SLAB DEAD LOAD *
25 QDL=150.0*HS/1728.0
YDL=QDL/KE
QU=QU-QDL$ QT=QT-QDL$ QFAIL=QFAIL-QDL
YU=YU-YDL$ YT=YT-YDL$ YFAIL=YFAIL-YDL
IF(KRAND.NE.1)PRINT 633,QDL,YDL
C
C OUTPUT LOAD-DEFLECTION CURVE
IF(KRAND.EQ.1)GOTO 335
PRINT 650
"F(MEMB.EQ.1)GOTO 332
PRINT 660,QU,YU,QU,YFAIL
GOTO 335
332 IF(QT.NE.QU)GOTO 333
PRINT 660,QU,YU,QI,YT,QFAIL,YFAIL
GOTO 335
333 PRINT 660,QU,YU,QU,YT,QT,YT,QFAIL,"TAIL
335 CONTINUE
C
C * CALCULATE MINIMUM SHEAR RESISTANCE *
VPS=3.0*SQRT(FPC)
Bd=C2+D(4)
```

```
30830 QSHR1=4.0*B0*(HS+HD)*VPS/(ZLS*ZLS-B0*B0)
30832 B0=ZLD+(D(4)-HD)
30834 QSHR2=4.0*B0*HS*VPS/(ZLS*ZLS-B0*B0)
30836 VBS=2.0*SQRT(F'C)
30838 QSHR3=HS*VBS/(0.5*(ZLS-C2)-D(3))
30840 QSHEAR=QSHR1
30841 IF(KRAND.NE.1)PRINT 957,QSHR1,QSHR2,QSHR3
30842 IF(QSHR2.LT.QSHEAR)QSHEAR=QSHR2
30844 IF(QSHR3.LT.QSHEAR)QSHEAR=QSHR3
30846 QSHEAR=QSHEAR-QDL
30850 IF(KRAND.NE.1)PRINT 695,QSHEAR
30852 VSHEAR=QSHEAR*AREA*0.25
30860 RETURN
30870C
30880C * ENTRY 3. DETERMINE THE RESISTANCE AS A FUNCTIØN ØF Y(I) *
30885 500 IF(JSHEAR.EQ.1)GØTØ 520
30890 IF(Y(I).GT.YU)GØTØ 510
30900C
30910C ELASTIC RANGE
30920 Q=Y(I)*KE
30930 ZKLM=0.64
30940 VS1=0.04 $ VS2=0.21
30950 RETURN
30960C
30970C PLASTIC RANGE
30980 510 IF(Y(I).GT.YFAIL)GØTØ 530
30990 ZKLM=7.0/12.0
31000 VS1=1.0/28.0 $ VS2=6.0/28.0
31010 IF(Y(I).GT.YT)GØTØ 520
31020 Q=QU
31030 RETURN
31040C
31050C TENSILE MEMBRANE RANGE
31060 520 Q=QT+(Y(I)-YT)*(QFAIL-QT)/(YFAIL-YT)
31070 RETURN
31080C
31090C FAILURE (SET RESISTANCE TØ VERY SMALL VALUE)
31100 530 Q=1E-11
31110 RETURN
31120C
31130 600 FØRMAT(/*INPUT LS,C2,   'PC,FDY,LD,HD*,+)
31140 610 FØRMAT(*INPUT AS,D,A'S,..  FØR SECTIØN*,I2,+)
31150 620 FØRMAT(/*PRØPERTIES ØF R/C FLAT SLAB ØR PLATE*,/
31160+     *  LS =*,F6.1,* IN.     C2 =*,F6.1,* IN.*,6X,*HS =*,
31170+     F6.1,* IN.*,/,* F'C =*,F7.1,* PSI   FDC =*,F7.1,
31180+     * PSI*,5X,*EC =*,F7.1,* KSI*,/,* FDY =*,F8.1,* PSI*,
31190+     3X,*ES =*,F8.1,* KSI*,/,*  LD =*,F6.1,* IN.     HD =*,F6.1,
31191+     * IN.*)
31200 630 FØRMAT(/*REINFØRCEMENT VALUES*/* SECTIØN    AS     (P)*,
31210+     9X,*D*,8X,*A'S    (P')*,8X,*D'*,/,8X,*(SQ IN./FT)*,10X,
31220+     *(IN.)    (SQ IN./FT)*,10X,*(IN.)*)
31230 633 FØRMAT(/*QDL =*,F6.2,* PSI     YDL =*,F8.2,* IN.*)
31240 640 FØRMAT(I5,F11.4,* (*,F6.4,*)*,F9.3,F10.4,* (*,F6.4,*)*,F9.3)
31250 650 FØRMAT(/*LØAD-DEFLECTIØN CURVE*,/,4X,*Q (PSI)   Y (IN.)*)
31260 660 FØRMAT(F9.2,F12.4)
31270 670 FØRMAT(1H )
31300 695 FØRMAT(/*QSHEAR =*,F9.2,* PSI*)
31310 706 FØRMAT(/*INPUT CØNTINUØUS REINFØRCEMENT (SQ IN./FT)*,+)
31320 711 FØRMAT(/*IS TENSILE MEMBRANE TØ BE INCLUDED *,
31330+     *(0=NØ;1=YES)*,+)
31335 720 FØRMAT(/*IS SHEAR FAILURE TØ BE CØNSIDERED*,
31336+    * (0=NØ;1=YES)*,+)
31338 957 FØRMAT(/*QSHR1 =*,F10.3,/,*QSHR2 =*,F10.3,/,*QSHR3 =*,F10.3)
31340 END
35000 SUBRØUTINE MØMENT(FDC,FDY,ES,N,PV,B,AS,APS,D,DP,MU,ICR,IC)
35010C THIS SUBRØUTINE DETERMINES THE ULTIMATE MØMENT CAPACITY AND
35020C CRACKED MØMENT ØF INERTIA  FØR REQUIRED SECTIØNS
35040 REAL K1,K2,K3,KUD,N,IC,ICTØT,MU(4),ICR(4),AS(4),APS(4),D(4),DP(4)
35050C
35060C: DETERMINE VALUES ØF CØNCRETE PARAMETERS
35070 45 K1=0.94-FDC/26E3
35080 K2=0.50-FDC/8E4
35090 K3=(3900.0+0.35*FDC)/(3E3+0.82*FDC-FDC*FDC/26E3)
35100 EPSC=0.004-FDC/65E5
```

PROGRAM FLAT (CONTINUED)

```
C: **********************************************************
C: * DETERMINE ULTIMATE MØMENT CAPACITY AND CRACKED *
C: * MØMENT ØF INERTIA FØR REQUIRED SECTIØNS        *
C: **********************************************************
C
 II=0; ICTØT=0
 DØ 170 I=1,4
 MU(I)=0
 IF(AS(I).EQ.0)GØTØ 170
 II=II+1
C: ALL PRØPERTIES ARE CØMPUTED FØR A WIDTH B
 TENS=AS(I)*FDY*PV
 IF(APS(I).LE.0)GØTØ 150
C
C: WALL HAS CØMPRESSIØN REINFØRCEMENT
 C=K1*K3*FDC*B*DP(I)
 TERM1=0.5*(TENS/APS(I)+ES*EPSC)
 TERM2=ES*EPSC*(TENS-C)/APS(I)
C: DETERMINE LØCATIØN ØF NEUTRAL AXIS
 IF(TENS.LE.C)GØTØ 140
C
C: KUD > D'
 FPS=TERM1+K3*FDC/2.0-SQRT((TERM1-K3*FDC/2.0)**2
+  -(TERM2+ES*EPSC*K3*FDC))
C: F'S MUST BE <= FDY
 IF(FPS.LT.FDY)GØTØ 130
 FPS=FDY
 130 TPS=APS(I)*(FPS-K3*FDC)
 KUD=(TEN-TPS)/(K1*K3*FDC*B)
 MU(I)=(TENS-TPS)*(D(I)-K2*KUD)+TPS*(D(I)-DP(I))
 ICR(I)=B*KUD**3/3.0+N*AS(I)*(D(I)-KUD)**2
+  +(N-1)*APS(I)*(KUD-DP(I))**2
 GØTØ 152
C
C: KUD < D'
 140 FPS=-TERM1+SQRT(TERM1**2-TERM2)
C: F'S MUST BE <= FDY
 IF(FPS.LT.FDY)GØTØ 145
 FPS=FDY
 145 TERM3=TENS+APS(I)*FPS
 KUD=TERM3/(K1*K3*FDC*B)
 MU(I)=TERM3*(D(I)-K2*KUD)-APS(I)*FPS*(D(I)-DP(I))
 ICR(I)=B*KUD**3/3+N*AS(I)*(D(I)-KUD)**2+N*APS(I)*(DP(I)-KUD)**2
 GØTØ 152
C
C: WALL HAS NØ CØMPRESSIØN REINFØRCEMENT
 150 KUD=TENS/(K1*K3*FDC*B)
 MU(I)=TENS*(D(I)-K2*KUD)
 ICR(I)=B*KUD**3/3.0+N*AS(I)*(D(I)-KUD)**2
C
 152 ICTØT=ICTØT+ICR(I)
 170 CØNTINUE
C
C: DETERMINE AVERAGE CRACKED MØMENT ØF INERTIA
 175 IC=ICTØT/II
 RETURN
 END
       SUBRØUTINE RANDØM (IENTRY)
C THIS SUBRØUTINE INPU   MEAN AND STANDARD DEVIATIØNS FØR RANDØM
C VARIABLES; GENERATI   NDØM VALUES; AND CØNTRØLS REQUIRED
C NUMBER ØF CASES TØ E   N; AND ØUTPUTS FINAL RESULTS AND SUMMARY
C
 CØMMØN KINC,LDTYPE,KRF,KRAND,TIME,II,Y(100),Q,QU,YU,YFAIL,
+  ZLS,HS,FDY,AREA,ZMASS,ZKLM,VS1,VS2,PSØ,PDØ,PR,PEXT,PC,TC,TO,
+  PØ,DELAY,S
 CØMMØN /SHEAR/ ISHEAR,JSHEAR,VSHEAR,MEMB
      CØMMØN /RAND/ TIMEC
 DIMENSIØN CHI25(7),CHI975(7),TDIST(7)
C
C VALUES FØR 97.5%  (F=19,24,29,34,39,44,49)
       DATA CHI25/.4688,.5167,.5533,.5825,.6065,.6267,.6440/
       DATA CHI975/1.7295,1.6402,1.5766,1.5284,1.4903,1.4591,1.4331/
       DATA TDIST/2.093,2.064,2.045,2.032,2.022,2.016,2.010/
C
```

PROGRAM FLAT (CONTINUED)

```
      GØTØ(5,50,70),IENTRY
    5 XDUMMY=XNØRMI(-1.0,0.0,1.0)
C INITIALIZE RANDØM NUMBER GENERATØR
      PRINT,/,*INPUT NRAND*,
      READ,NRAND
      DØ 47 I=1,NRAND
      XDUMMY=XNØRMI(0.0,0.0,1.0)
   47 CØNTINUE
      INDEX=0$  SPSØ=0$  SSPSØ=0
      ICHECK=20
C
C  INPUT MEAN AND STANDARD DEVIATIØN FØR RANDØM VARIABLES
      IF(KRF.EQ.0)GØTØ 30
      PRINT 87
      READ,SMEAN,SSD
C  REINFØRCED CØNCRETE WALLS
   30 PRINT 86
      READ,FDYMEAN,FDYSD
      IF(KRF.EQ.1)PRINT 96
      IF(KRF.EQ.0)PRINT 97
      RETURN
C
C  GENERATE RANDØM VALUES
   50 FDY=XNØRMI(0.0,FDYMEAN,FDYSD)
      IF(FDY.LE.0)GØTØ 50
      IF(KRF.EQ.0)GØTØ 65
   60 S=XNØRMI(0.0,SMEAN,SSD)
      IF(S.LE.0)GØTØ 60
   65 INDEX=INDEX+1
      RETURN
C SUM VALUES ØF PSØ AND PSØ**2 FØR USE IN STATISTICAL ANALYSIS
   70 SPSØ=SPSØ+PSØ
      SSPSØ=SSPSØ+PSØ*PSØ
C
C ØUTPUT FINAL RESULTS
   76 IF(KRF.EQ.1)PRINT 92,FDY,S,PSØ,TIMEC
      IF(KRF.EQ.0)PRINT 90,FDY,PSØ,TIMEC
      IF(JSHEAR.EQ.1)PRINT 110
      IF(JSHEAR.NE.1)PRINT 120
   80 IF(INDEX.LT.ICHECK)RETURN
C
C DETERMINE MEAN, STANDARD DEVIATIØN, AND STANDARD ERRØR FØR PSØ
      ZNØ=INDEX
      ZMEAN=SPSØ/ZNØ
      SD=SQRT((SSPSØ-ZNØ*ZMEAN*ZMEAN)/ZNØ)
      STDERR=SD/(SQRT(ZNØ-1))
C CHECK IF MAXIMUM ØF 50 PSØ SAMPLES ØBTAINED
      IF(INDEX.EQ.50)GØTØ 62
C CHECK IF 95% CØNFIDENCE INTERVAL FØR MEAN PSØ VALUE IS
      IF(STDERR*TDIST((INDEX-15)/5)/ZMEAN.GT.0.10)GØTØ 61
C
C CØNFIDENCE INTERVAL IS WITHIN 10%  - DETERMINE UPPER LIMIT ØF
C 95% CØNFIDENCE INTERVAL FØR STANDARD DEVIATIØN
C PRØBABILITY VALUE AND ITS 95% CØNFIDENCE INTERVAL UPPER LIMIT
   62 SDU=SD/(SQRT(CHI25((INDEX-15)/5)))
C CHECK IF MAXIMUM ØF 50 PSØ SAMPLES ØBTAINED
      IF(INDEX.EQ.50)GØTØ 53
C CHECK IF UPPER VALUE ØF 95% CØNFIDENCE INTERVAL FØR STANDARD
C DEVIATIØN IS WITHIN 0.10*MEAN ØF THE STANDARD DEVIATIØN
      IF(((SDU-SD)/ZMEAN).GT.0.10)GØTØ 61
C
C 95% CØNFIDENCE INTERVAL IS WITHIN 10% FØR BØTH MEAN AND 90%
C PRØBABILITY VALUE -- THEREFØRE SUFFICIENT SAMPLES ØBTAINED
C DETERMINE 95% CØNFIDENCE INTERVALS FØR MEAN, STANDARD DEVIATIØN
,
C AND 10% AND 90% PRØBABILITY VALUES
   53 ZMEANL=ZMEAN-STDERR*TDIST((INDEX-15)/5)
      ZMEANU=ZMEAN+STDERR*TDIST((INDEX-15)/5)
      SDL=SD/(SQRT(CHI975((INDEX-15)/5)))
      P10=ZMEAN-1.282*SD
      P10L=ZMEAN-1.282*SDU
      P10U=ZMEAN-1.282*SDL
      P90=ZMEAN+1.282*SD
      P90L=ZMEAN+1.282*SDL
```

PROGRAM FLAT (CONCLUDED)

```
      P90=ZMEAN+1.282*SD
      P90U=ZMEAN+1.282*SDU
      P90U=ZMEAN+1.282*SDU
C
C OUTPUT STATISTICAL PARAMETERS OF INCIPIENT COLLAPSE PRESSURE
      PRINT 100,ZMEAN,ZMEANL,ZMEANU,SD,SDL,SDU,P10,P10L,P10U,
+       P90,P90L,P90U
      PRINT 105,INDEX,STDERR
      GOTO 999
C
C 95% CONFIDENCE INTERVAL IS NOT WITHIN 10% FOR BOTH MEAN AND 90
B
C VALUES -- THEREFORE OBTAIN 5 ADDITIONAL SAMPLES
   61 ICHECK=ICHECK+5
      RETURN
C
   86 FORMAT(/*INPUT MEAN AND STANDARD DEVIATION FOR FDY*,+)
   87 FORMAT(/*INPUT MEAN AND STANDARD DEVIATION FOR S*,+)
   90 FORMAT(F9.1,F10.2,F14.3,+)
   92 FORMAT(F9.1,F11.2,F10.2,F14.3,+)
   96 FORMAT(///,5X,*FDY*,9X,*S*,8X,*PSO*,6X,*COLLAPSE TIME*)
   97 FORMAT(///,4X,FDY,9X,*PSO*,4X,*COLLAPSE TIME*)
  100 FORMAT(///,11X,*STATISTICAL PROPERTIES OF INCIPIENT PSO*,
+       //,39X,*95% CONFIDENCE LIMITS*,/,7X,*ITEM*,18X,
+       *VALUE        LOWER        UPPER*,//,* MEAN*,F29.2,
+       2F12.2,///,* STANDARD DEVIATION*,F15.2,2F12.2,///,
+       * 10% PROBABILITY VALUE*,3F12.2,//,
+       * 90% PROBABILITY VALUE*,3F12.2)
  105 FORMAT(//,5X,*NUMBER OF OBSERVATIONS   *,I3,/,5X,
+       *STANDARD ERROR =*,F5.2)
  110 FORMAT(5X,*:SHEAR FAILURE)*)
  120 FORMAT(* *)
  999 STOPS END
FUNCTION XNORMI(X,A,B)
IF(X)10,20,20
10 XO=RANF(-1.0)
20 X1=RANF(0.0)
X2=RANF(0.0)
Y=SQRT(-2.0*ALOG(X1))*(COS(6.283184*X2))
XNORMI=A+Y*B
RETURN
END
```

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NOMENCLATURE

	Area of concrete section, sq in.
	Area of tension steel in reinforced concrete slab per unit width, sq in./in.
	Area of window, sq ft
	Width of cross section, in.
	Width of wall between edge of door opening and areaway support wall, in.
	Distance from compressive face of reinforced concrete slab to centroid of tension steel, in.
	Compressive strength of 6- by 12-in. concrete cylinder, psi
	Dynamic compressive strength of concrete, psi
	Dynamic yield strength of reinforcing steel, psi
	Ultimate compressive strength of masonry unit wall, psi
	Modulus of rupture, psi
	Static yield strength of reinforcing steel, psi
	Soil depth, ft
	Lateral soil coefficient
	Span length, in.
	Horizontal length (width) of wall, in.
	Vertical length (height) of wall, in.
	Bending moment per unit width, in.-lb/in.
	Ultimate moment capacity per unit width, in.-lb/in.
	Steel ratio, tension steel
t)	Unit pressure exerted against any surface varying with time, psi
p_h	Lateral static soil pressure, psf
p_r	Reflected overpressure, psi
p_{so}	Peak incident overpressure, psi
P_T	Total lateral load acting on wall, lb
P_v	Total vertical force per unit width, lb/in.
q	Unit resistance for uniformly loaded member, psi
S	Clearing distance, ft
t_c	Clearing time, front face, sec
t_o	Duration of positive overpressure, sec
t_w	Thickness of wall, in.
V	Total shear per unit width, lb/in.
$(V_c)_s$	Total shear capacity per unit width at support, lb/in.
$(v_c)_s$	Unit shear capacity per unit width at support, psi
W	Weapon yield
γ	Unit weight, pcf
o	Unit weight of soil, pcf
φ	Coefficient of flexure